2018 SchweserNotes™ Part II

FRM® Exam Prep

Operational and Integrated Risk Management

eBook 3

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Sincerely,

Derek Burkett

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FRM Part II Book 3: Operational and Integrated Risk Management

FRM 2018 PART II BOOK 3: OPERATIONAL AND INTEGRATED RISK MANAGEMENT

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Reading Assignments and Learning Objectives

The following material is a review of the Operational and Integrated Risk Management principles designed to address the learning objectives set forth by the Global Association of Risk Professionals.

Reading Assignments

Learning Objectives

37. Principles for the Sound Management of Operational Risk

After completing this reading, you should be able to:
1. Describe the three "lines of defense" in the Basel model for operational risk governance. (page 1)
2. Summarize the fundamental principles of operational risk management as suggested by the Basel committee. (page 2)
3. Explain guidelines for strong governance of operational risk, and evaluate the role of the board of directors and senior management in implementing an effective operational risk framework. (page 3)
4. Describe tools and processes that can be used to identify and assess operational risk. (page 7)
5. Describe features of an effective control environment and identify specific controls that should be in place to address operational risk. (page 7)
6. Explain the Basel Committee's suggestions for managing technology risk and outsourcing risk. (page 8)

38. Enterprise Risk Management: Theory and Practice

After completing this reading, you should be able to:
1. Define enterprise risk management (ERM) and explain how implementing ERM practices and policies can create shareholder value, both at the macro and the micro level. (page 15)
2. Explain how a company can determine its optimal amount of risk through the use of credit rating targets. (page 17)
3. Describe the development and implementation of an ERM system, as well as challenges to the implementation of an ERM system. (page 17)
4. Describe the role of and issues with correlation in risk aggregation, and describe typical properties of a firm's market risk, credit risk, and operational risk distributions. (page 18)
5. Distinguish between regulatory and economic capital, and explain the use of economic capital in the corporate decision making process. (page 19)

39. Observations on Developments in Risk Appetite Frameworks and IT Infrastructure

After completing this reading, you should be able to:
1. Describe the concept of a risk appetite framework (RAF), identify the elements of an RAF, and explain the benefits to a firm of having a well-developed RAF. (page 25)
2. Describe best practices for a firm's Chief Risk Officer (CRO), Chief Executive Officer (CEO), and its board of directors in the development and implementation of an effective RAF. (page 26)
3. Explain the role of an RAF in managing the risk of individual business lines within a firm, and describe best practices for monitoring a firm's risk profile for adherence to the RAF. (page 27)
4. Explain the benefits to a firm from having a robust risk data infrastructure, and describe key elements of an effective IT risk management policy at a firm. (page 28)
5. Describe factors that can lead to poor or fragmented IT infrastructure at an organization. (page 29)
6. Explain the challenges and best practices related to data aggregation at an organization. (page 30)

40. Information Risk and Data Quality Management

After completing this reading, you should be able to:
1. Identify the most common issues that result in data errors. (page 36)
2. Explain how a firm can set expectations for its data quality and describe some key dimensions of data quality used in this process. (page 36)
3. Describe the operational data governance process, including the use of scorecards in managing information risk. (page 38)

41. OpRisk Data and Governance

After completing this reading, you should be able to:
1. Describe the seven Basel II event risk categories and identify examples of operational risk events in each category. (page 43)
2. Summarize the process of collecting and reporting internal operational loss data, including the selection of thresholds, the timeframe for recoveries, and reporting expected operational losses. (page 46)
3. Explain the use of a Risk Control Self-Assessment (RCSA) and key risk indicators (KRIs) in identifying, controlling, and assessing operational risk exposures. (page 48)
4. Describe and assess the use of scenario analysis in managing operational risk, and identify biases and challenges that can arise when using scenario analysis. (page 51)
5. Compare the typical operational risk profiles of firms in different financial sectors. (page 53)
6. Explain the role of operational risk governance and explain how a firm's organizational structure can impact risk governance. (page 56)

42. External Loss Data

After completing this reading, you should be able to:
1. Explain the motivations for using external operational loss data and common sources of external data. (page 61)
2. Explain ways in which data from different external sources may differ. (page 64)
3. Describe the challenges that can arise through the use of external data. (page 65)
4. Describe the Société Générale operational loss event and explain the lessons learned from the event. (page 66)

43. Capital Modeling

After completing this reading, you should be able to:
1. Compare the basic indicator approach, the standardized approach, and the alternative standardized approach for calculating the operational risk capital charge, and calculate the Basel operational risk charge using each approach. (page 73)
2. Describe the modeling requirements for a bank to use the Advanced Measurement Approach (AMA). (page 78)
3. Describe the loss distribution approach to modeling operational risk capital. (page 79)
4. Explain how frequency and severity distributions of operational losses are obtained, including commonly used distributions and suitability guidelines for probability distributions. (page 79)
5. Explain how Monte Carlo simulation can be used to generate additional data points to estimate the 99.9^{th} percentile of an operational loss distribution. (page 81)
6. Explain the use of scenario analysis and the hybrid approach in modeling operational risk capital. (page 81)

44. Standardized Measurement Approach for Operational Risk

After completing this reading, you should be able to:

1. Explain the elements of the proposed Standardized Measurement Approach (SMA), including the business indicator, internal loss multiplier and loss component, and calculate the operational risk capital requirement for a bank using the SMA. (page 86)
2. Compare the SMA to earlier methods of calculating operational risk capital, including the Alternative Measurement Approaches (AMA), and explain the rationale for the proposal to replace them. (page 90)
3. Describe general and specific criteria recommended by the Basel Committee for the identification, collection, and treatment of operational loss data. (page 91)

45. Parametric Approaches (II): Extreme Value

After completing this reading, you should be able to:

1. Explain the importance and challenges of extreme values in risk management. (page 96)
2. Describe extreme value theory (EVT) and its use in risk management. (page 96)
3. Describe the peaks-over-threshold (POT) approach. (page 98)
4. Compare and contrast generalized extreme value and POT. (page 100)
5. Evaluate the tradeoffs involved in setting the threshold level when applying the GP distribution. (page 98)
6. Explain the importance of multivariate EVT for risk management. (page 100)

46. Validating Rating Models

After completing this reading, you should be able to:

1. Explain the process of model validation and describe best practices for the roles of internal organizational units in the validation process. (page 104)
2. Compare qualitative and quantitative processes to validate internal ratings, and describe elements of each process. (page 107)
3. Describe challenges related to data quality and explain steps that can be taken to validate a model's data quality. (page 109)
4. Explain how to validate the calibration and the discriminatory power of a rating model. (page 111)

47. Model Risk

After completing this reading, you should be able to:

1. Identify and explain errors in modeling assumptions that can introduce model risk. (page 116)
2. Explain how model risk can arise in the implementation of a model. (page 118)
3. Explain methods and procedures risk managers can use to mitigate model risk. (page 119)
4. Explain the impact of model risk and poor risk governance in the 2012 London Whale trading loss and the 1998 collapse of Long Term Capital Management. (page 120)

48. Risk Capital Attribution and Risk-Adjusted Performance Measurement

After completing this reading, you should be able to:
1. Define, compare, and contrast risk capital, economic capital, and regulatory capital, and explain methods and motivations for using economic capital approaches to allocate risk capital. (page 128)
2. Describe the RAROC (risk-adjusted return on capital) methodology and its use in capital budgeting. (page 130)
3. Compute and interpret the RAROC for a project, loan, or loan portfolio, and use RAROC to compare business unit performance. (page 130)
4. Explain challenges that arise when using RAROC for performance measurement, including choosing a time horizon, measuring default probability, and choosing a confidence level. (page 133)
5. Calculate the hurdle rate and apply this rate in making business decisions using RAROC. (page 135)
6. Compute the adjusted RAROC for a project to determine its viability. (page 136)
7. Explain challenges in modeling diversification benefits, including aggregating a firm's risk capital and allocating economic capital to different business lines. (page 136)
8. Explain best practices in implementing an approach that uses RAROC to allocate economic capital. (page 138)

49. Range of Practices and Issues in Economic Capital Frameworks

After completing this reading, you should be able to:
1. Within the economic capital implementation framework describe the challenges that appear in:
   - Defining and calculating risk measures
   - Risk aggregation
   - Validation of models
   - Dependency modeling in credit risk
   - Evaluating counterparty credit risk
   - Assessing interest rate risk in the banking book (page 146)
2. Describe the BIS recommendations that supervisors should consider to make effective use of internal risk measures, such as economic capital, that are not designed for regulatory purposes. (page 156)
3. Explain benefits and impacts of using an economic capital framework within the following areas:
   - Credit portfolio management
   - Risk based pricing
   - Customer profitability analysis
   - Management incentives (page 157)
4. Describe best practices and assess key concerns for the governance of an economic capital framework. (page 158)

50. Capital Planning at Large Bank Holding Companies: Supervisory Expectations and Range of Current Practice

After completing this reading, you should be able to:
1. Describe the Federal Reserve's Capital Plan Rule and explain the seven principles of an effective capital adequacy process for bank holding companies (BHCs) subject to the Capital Plan Rule. (page 164)

2. Describe practices that can result in a strong and effective capital adequacy process for a BHC in the following areas:
   - Risk identification
   - Internal controls, including model review and valuation
   - Corporate governance
   - Capital policy, including setting of goals and targets and contingency planning
   - Stress testing and stress scenario design
   - Estimating losses, revenues, and expenses, including quantitative and qualitative methodologies
   - Assessing the impact of capital adequacy, including risk-weighted asset (RWA) and balance sheet projections (page 166)

51. Repurchase Agreements and Financing

After completing this reading, you should be able to:

1. Describe the mechanics of repurchase agreements (repos) and calculate the settlement for a repo transaction. (page 178)
2. Explain common motivations for entering into repos, including their use in cash management and liquidity management. (page 179)
3. Explain how counterparty risk and liquidity risk can arise through the use of repo transactions. (page 181)
4. Assess the role of repo transactions in the collapses of Lehman Brothers and Bear Stearns during the (2007–2009) credit crisis. (page 182)
5. Compare the use of general and special collateral in repo transactions. (page 183)
6. Describe the characteristics of special spreads and explain the typical behavior of US Treasury special spreads over an auction cycle. (page 185)
7. Calculate the financing advantage of a bond trading special when used in a repo transaction. (page 186)

52. Estimating Liquidity Risks

After completing this reading, you should be able to:

1. Define liquidity risk and describe factors that influence liquidity, including the bid-ask spread. (page 192)
2. Differentiate between exogenous and endogenous liquidity. (page 193)
3. Describe the challenges of estimating liquidity-adjusted VaR (LVaR). (page 193)
4. Describe and calculate LVaR using the constant spread approach and the exogenous spread approach. (page 194)
5. Describe endogenous price approaches to LVaR, their motivation and limitations, and calculate the elasticity-based liquidity adjustment to VaR. (page 197)
6. Describe liquidity at risk (LaR) and compare it to LVaR and VaR, describe the factors that affect future cash flows, and explain challenges in estimating and modeling LaR. (page 199)
7. Describe approaches to estimate liquidity risk during crisis situations and challenges which can arise during this process. (page 200)

53. Assessing the Quality of Risk Measures

After completing this reading, you should be able to:

1. Describe ways that errors can be introduced into models. (page 206)
2. Explain how model risk and variability can arise through the implementation of VaR models and the mapping of risk factors to portfolio positions. (page 207)

3. Identify reasons for the failure of the long-equity tranche, short-mezzanine credit trade in 2005 and describe how such modeling errors could have been avoided. (page 209)
4. Explain major defects in model assumptions that led to the underestimation of systematic risk for residential mortgage backed securities (RMBS) during the 2007–2009 financial downturn. (page 211)

54. Liquidity and Leverage

After completing this reading, you should be able to:

1. Differentiate between sources of liquidity risk, including balance sheet/funding liquidity risk, systematic funding liquidity risk, and transactions liquidity risk, and explain how each of these risks can arise for financial institutions. (page 216)
2. Summarize the asset-liability management process at a fractional reserve bank, including the process of liquidity transformation. (page 217)
3. Describe specific liquidity challenges faced by money market mutual funds and by hedge funds, particularly in stress situations. (page 219)
4. Compare transactions used in the collateral market and explain risks that can arise through collateral market transactions. (page 220)
5. Describe the relationship between leverage and a firm's return profile, calculate the leverage ratio, and explain the leverage effect. (page 222)
6. Explain the impact on a firm's leverage and its balance sheet of the following transactions: purchasing long equity positions on margin, entering into short sales, and trading in derivatives. (page 224)
7. Explain methods to measure and manage funding liquidity risk and transactions liquidity risk. (page 228)
8. Calculate the expected transactions cost and the spread risk factor for a transaction, and calculate the liquidity adjustment to VaR for a position to be liquidated over a number of trading days. (page 229)
9. Explain interactions between different types of liquidity risk and explain how liquidity risk events can increase systemic risk. (page 216)

55. The Failure Mechanics of Dealer Banks

After completing this reading, you should be able to:

1. Describe the major lines of business in which dealer banks operate and the risk factors they face in each line of business. (page 237)
2. Identify situations that can cause a liquidity crisis at a dealer bank and explain responses that can mitigate these risks. (page 241)
3. Describe policy measures that can alleviate firm-specific and systemic risks related to large dealer banks. (page 244)

56. Stress Testing Banks

After completing this reading, you should be able to:

1. Describe the historical evolution of the stress testing process and compare methodologies of historical EBA, CCAR and SCAP stress tests. (page 249)
2. Explain challenges in designing stress test scenarios, including the problem of coherence in modeling risk factors. (page 250)
3. Explain challenges in modeling a bank's revenues, losses, and its balance sheet over a stress test horizon period. (page 251)

57. Guidance on Managing Outsourcing Risk

After completing this reading, you should be able to:

1. Explain how risks can arise through outsourcing activities to third-party service providers, and describe elements of an effective program to manage outsourcing risk. (page 259)
2. Explain how financial institutions should perform due diligence on third-party service providers. (page 260)
3. Describe topics and provisions that should be addressed in a contract with a third-party service provider. (page 261)

58. Basel I, Basel II, and Solvency II

After completing this reading, you should be able to:

1. Explain the motivations for introducing the Basel regulations, including key risk exposures addressed, and explain the reasons for revisions to Basel regulations over time. (page 267)
2. Explain the calculation of risk-weighted assets and the capital requirement per the original Basel I guidelines. (page 268)
3. Describe and contrast the major elements—including a description of the risks covered—of the two options available for the calculation of market risk capital:
   - Standardized Measurement Method
   - Internal Models Approach (page 271)
4. Calculate VaR and the capital charge using the internal models approach, and explain the guidelines for backtesting VaR. (page 272)
5. Describe and contrast the major elements of the three options available for the calculation of credit risk capital:
   - Standardized Approach
   - Foundation IRB Approach
   - Advanced IRB Approach (page 274)
6. Describe and contrast the major elements of the three options available for the calculation of operational risk capital: basic indicator approach, standardized approach, and the Advanced Measurement Approach. (page 280)
7. Describe the key elements of the three pillars of Basel II: minimum capital requirements, supervisory review, and market discipline. (page 280)
8. Define in the context of Basel II and calculate the worst-case default rate (WCDR). (page 274)
9. Differentiate between solvency capital requirements (SCR) and minimum capital requirements (MCR) in the Solvency II framework, and describe the repercussions to an insurance company for breaching the SCR and MCR. (page 282)
10. Compare the standardized approach and the Internal Models Approach for calculating the SCR in Solvency II. (page 282)

59. Basel II.5, Basel III, and Other Post-Crisis Changes

After completing this reading, you should be able to:

1. Describe and calculate the stressed VaR measure introduced in Basel 2.5, and calculate the market risk capital charge. (page 290)
2. Explain the process of calculating the incremental risk capital charge for positions held in a bank's trading book. (page 292)
3. Describe the comprehensive risk measure (CRM) for positions that are sensitive to correlations between default risks. (page 292)

4. Define in the context of Basel III and calculate where appropriate.
    - Tier 1 capital and its components
    - Tier 2 capital and its components
    - Required Tier 1 equity capital, total Tier 1 capital, and total capital (page 294)
5. Describe the motivations for and calculate the capital conservation buffer and the countercyclical buffer introduced in Basel III. (page 295)
6. Describe and calculate ratios intended to improve the management of liquidity risk, including the required leverage ratio, the liquidity coverage ratio, and the net stable funding ratio. (page 296)
7. Describe the mechanics of contingent convertible bonds (CoCos) and explain the motivations for banks to issue them. (page 299)
8. Explain the major changes to the US financial market regulations as a result of Dodd-Frank. (page 300)

60. Fundamental Review of the Trading Book

After completing this reading, you should be able to:

1. Describe the proposed changes to the Basel market risk capital calculation and the motivations for these changes, and calculate the market risk capital under this method. (page 307)
2. Compare the various liquidity horizons proposed by the Fundamental Review of the Trading Book (FRTB) for different asset classes and explain how a bank can calculate its expected shortfall using the various horizons. (page 309)
3. Explain proposed modifications to Basel regulations in the following areas:
    - Classification of positions in the trading book compared to the banking book
    - Treatment of credit spread and jump-to-default risk, including the incremental default risk charge (page 311)

61. Sound Management of Risks Related to Money Laundering and Financing of Terrorism

After completing this reading, you should be able to:

1. Explain best practices recommended by the Basel Committee for the assessment, management, mitigation, and monitoring of money laundering and financial terrorism (ML/FT) risks. (page 316)
2. Describe recommended practices for the acceptance, verification, and identification of customers at a bank. (page 318)
3. Explain practices for managing ML/FT risks in a group-wide and cross-border context, and describe the roles and responsibilities of supervisors in managing these risks. (page 320)
4. Explain policies and procedures a bank should use to manage ML/FT risks in situations where it uses a third party to perform customer due diligence and when engaging in correspondent banking. (page 322)

The following is a review of the Operational and Integrated Risk Management principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

Principles for the Sound Management of Operational Risk

Topic 37

Exam Focus

This is a descriptive topic that addresses the principles of sound operational risk management as proposed by the Basel Committee on Banking Supervision. The committee describes a three lines of defense approach, which includes business line management, independent operational risk management, and independent reviews. The committee suggests that a bank should have a corporate operational risk function (CORF) that is commensurate with the size and complexity of the banking organization. For the exam, understand the 11 principles of operational risk management as outlined by the Basel Committee. Know the specific responsibilities of the board of directors and senior managers as they relate to the 11 principles of operational risk management. Be able to explain the critical components of the bank's operational risk management framework documentation, and know the features of an effective control environment. Lastly, understand the committee's recommendations for managing technology and outsourcing risk.

Operational Risk Governance

LO 37.1: Describe the three "lines of defense" in the Basel model for operational risk governance.

The Basel Committee on Banking Supervision defines **operational risk** as "the risk of loss resulting from inadequate or failed internal processes, people and systems or from external events." The committee states that the definition excludes strategic and reputational risks but includes legal risks. Operational risk is inherent in banking activities. Risks range from those arising from national disasters, such as hurricanes, to the risk of fraud. The committee intends to improve operational risk management throughout the banking system.

Sound operational risk management practices cover governance, the risk management environment, and the role of disclosure. Operational risk management must be fully integrated into the overall risk management processes of the bank.

The three common "lines of defense" employed by firms to control operational risks are:

1. **Business line management**. Business line management is the first line of defense. Banks now, more than ever, have multiple lines of business, all with varying degrees of operational risk. Risks must be identified and managed within the various products, activities, and processes of the bank.

2. An **independent operational risk management function**. This is the second line of defense and is discussed in the next section.

3. **Independent reviews** of operational risks and risk management. The review may be conducted internally with personnel independent of the process under review or externally.

Corporate Operational Risk Function (CORF)

The bank's specific business lines monitor, measure, report, and manage operational and other risks. The corporate operational risk function (CORF), also known as the corporate operational risk management function, is a functionally independent group that complements the business lines' risk management operations. The CORF is responsible for designing, implementing, and maintaining the bank's operational risk framework. Responsibilities of the CORF may include:

- Measurement of operational risks.
- Establishing reporting processes for operational risks.
- Establishing risk committees to measure and monitor operational risks.
- Reporting operational risk issues to the board of directors.

In general, the CORF must assess and challenge each business line's contributions to risk measurement, management, and reporting processes.

Larger, more complex banking institutions will typically have a more formalized approach to the implementation of the lines of defense against operational risks, including the implementation of the CORF. For example, a large bank may have a fully staffed group skilled specifically in operational risk management, while a smaller bank may simply fold operational risk management into the broader risk management function of the bank.

Principles of Operational Risk Management

LO 37.2: Summarize the fundamental principles of operational risk management as suggested by the Basel committee.

Operational risks must be proactively managed by a bank's board of directors and senior managers as well as its business line managers and employees. The 11 fundamental principles of operational risk management suggested by the Basel Committee are:

1. The maintenance of a **strong risk management culture** led by the bank's board of directors and senior managers. This means that both individual and corporate values and attitudes should support the bank's commitment to managing operational risks.

2. The operational risk framework (referred to as the "Framework" in this topic) must be **developed and fully integrated into the overall risk management processes** of the bank.

3. The board should **approve and periodically review** the Framework. The board should also oversee senior management to ensure that appropriate risk management decisions are implemented at all levels of the firm.

4. The board must identify the types and levels of operational risks the bank is willing to assume as well as approve **risk appetite and risk tolerance statements.**

5. Consistent with the bank's risk appetite and risk tolerance, senior management must **develop a well-defined governance structure** within the bank. The structure must be implemented and maintained throughout the bank's various lines of business, its processes, and its systems. The board of directors should approve this governance structure.

6. Senior management must **understand the risks, and the incentives related to those risks, inherent in the bank's business lines and processes**. These operational risks must be identified and assessed by managers.

7. New lines of business, products, processes, and systems should require an **approval process that assesses the potential operational risks**. Senior management must make certain this approval process is in place.

8. A **process for monitoring operational risks and material exposures to losses** should be put in place by senior management and supported by senior management, the board of directors and business line employees.

9. Banks must put strong **internal controls, risk mitigation, and risk transfer strategies** in place to manage operational risks.

10. Banks must have plans in place to survive in the event of a major business disruption. **Business operations must be resilient.**

11. Banks should make **disclosures** that are clear enough that outside stakeholders can assess the bank's approach to operational risk management.

The Role of the Board and Senior Management

LO 37.3: Explain guidelines for strong governance of operational risk, and evaluate the role of the board of directors and senior management in implementing an effective operational risk framework.

The attitudes and expectations of the board of directors and senior management are critical to an effective operational risk management program.

With respect to Principle 1, the board of directors and/or senior management should:

- **Provide a sound foundation for a strong risk management culture** within the bank. A strong risk management culture will generally mitigate the likelihood of damaging operational risk events.

- **Establish a code of conduct (or ethics policy) for all employees** that outlines expectations for ethical behavior. The board of directors should support senior managers in producing a code of conduct. Risk management activities should reinforce the code of conduct. The code should be reflected in training and compensation as well as risk management. There should be a balance between risks and rewards. Compensation should be aligned not just with performance, but also with the bank's risk appetite, strategic direction, financial goals, and overall soundness.
- **Provide risk training** throughout all levels of the bank. Senior management should ensure training reflects the responsibilities of the person being trained.

With respect to Principle 2, the board of directors and/or senior management should:

- **Thoroughly understand both the nature and complexity of the risks** inherent in the products, lines of business, processes, and systems in the bank. Operational risks are inherent in all aspects of the bank.
- Ensure that the **Framework is fully integrated in the bank's overall risk management plan** across all levels of the firm (i.e., business lines, new business lines, products, processes, and/or systems). Risk assessment should be a part of the business strategy of the bank.

With respect to Principle 3, the board of directors and/or senior management should:

- **Establish a culture and processes** that help bank managers and employees understand and manage operational risks. The board must develop comprehensive and dynamic oversight and control mechanisms that are integrated into risk management processes across the bank.
- **Regularly review the Framework.**
- **Provide senior management with guidance** regarding operational risk management and approve policies developed by senior management aimed at managing operational risk.
- Ensure that the Framework is subject to **independent review**.
- **Ensure that management is following best practices** in the field with respect to operational risk identification and management.
- **Establish clear lines of management responsibility** and establish strong internal controls.

With respect to Principle 4, the board of directors and/or senior management should:

- **Consider all relevant risks** when approving the bank's risk appetite and tolerance statements. The board must also consider the bank's strategic direction. The board should approve risk limits and thresholds.
- **Periodically review** the risk appetite and tolerance statements. The review should specifically focus on:
  - Changes in the market and external environment.
  - Changes in business or activity volume.
  - Effectiveness of risk management strategies.
  - The quality of the control environment.
  - The nature of, frequency of, and volume of breaches to risk limits.

With respect to Principle 5, the board of directors and/or senior management should:

- **Establish systems to report and track operational risks** and maintain an effective mechanism for resolving problems. Banks should demonstrate the effective use of the three lines of defense to manage operational risk, as outlined by the Basel Committee.

- Translate the Framework approved by the board into **specific policies and procedures** used to manage risk. Senior managers should clearly assign areas of responsibility and should ensure a proper management oversight system to monitor risks inherent in the business unit.
- Ensure that operational risk managers **communicate clearly** with personnel responsible for market, credit, liquidity, interest rate, and other risks and with those procuring outside services, such as insurance or outsourcing.
- Ensure that CORF managers should have **sufficient stature** in the bank, commensurate with market, credit, liquidity, interest rate, and other risk managers.
- Ensure that the staff is **well trained in operational risk management**. Risk managers should have independent authority relative to the operations they oversee.
- Develop a **governance structure of the bank that is commensurate with the size and complexity** of the firm. Regarding the governance structure, the bank should consider:
  - *Committee structure*: for large, complex banks, a board-created firm level risk committee should oversee all risks. The management-level operational risk committee would report to the enterprise level risk committee.
  - *Committee composition*: committee members should have business experience, financial experience, and independent risk management experience. Independent, non-executive board members may also be included.
  - *Committee operation*: committees should meet frequently enough to be productive and effective. The committee should keep complete records of committee meetings.

With respect to Principle 6, the board of directors and/or senior management should:

- **Consider both internal and external factors** to identify and assess operational risk. Examples of tools that may be used to identify and assess risk are described in LO 37.4.

With respect to Principle 7, the board of directors and/or senior management should:

- **Maintain a rigorous approval process for new products and processes.** The bank should make sure that risk management operations are in place from the inception of new activities because operational risks typically increase when a bank engages in new activities, new product lines, enters unfamiliar markets, implements new business processes, puts into operation new technology, and/or engages in activities that are geographically distant from the main office.
- Thoroughly **review new activities and product lines**, reviewing inherent risks, potential changes in the bank's risk appetite or risk limits, necessary controls required to mitigate risks, residual risks, and the procedures used to monitor and manage operational risks.

With respect to Principle 8, the board of directors and/or senior management should:

- **Continuously improve the operational risk reporting.** Reports should be manageable in scope but comprehensive and accurate in nature.
- Ensure that **operational risk reports are timely.** Banks should have sufficient resources to produce reports during both stressed and normal market conditions. Reports should be provided to the board and senior management.
- Ensure that operational risk reports include:
  - Breaches of the bank's risk appetite and tolerance statement.
  - Breaches of the bank's thresholds and risk limits.
  - Details of recent operational risk events and/or losses.
  - External events that may impact the bank's operational risk capital.
  - Both internal and external factors that may affect operational risk.

With respect to Principle 9, the board of directors and/or senior management should have a sound internal control system as described in LO 37.5 (an effective control environment) and LO 37.6 (managing technology and outsourcing risks).

Banks may need to transfer risk (e.g., via insurance contracts) if it cannot be adequately managed within the bank. However, sound risk management controls must be in place and thus **risk transfer should be seen as a complement to, rather than a replacement for, risk management controls**. New risks, such as counterparty risks, may be introduced when the bank transfers risk. These additional risks must also be identified and managed.

With respect to Principle 10, the board of directors and/or senior management should:

- **Establish continuity plans** to handle unforeseen disruptive events (e.g., disruptions in technology, damaged facilities, pandemic illnesses that affect personnel, and so on). Plans should include impact analysis and plans for recovery. Continuity plans should identify key facilities, people, and processes necessary for the business to operate. The plan must also identify external dependencies such as utilities, vendors, and other third party providers.
- **Periodically review continuity plans**. Personnel must be trained to handle emergencies and, where possible, the bank should perform disaster recovery and continuity tests.

With respect to Principle 11, the board of directors and/or senior management should:

- Write public disclosures such that stakeholders can assess the bank's operational risk management strategies.
- **Write public disclosures that are consistent** with risk management procedures. The disclosure policy should be established by the board of directors and senior management and approved by the board of directors. The bank should also be able to verify disclosures.

Operational Risk Management Framework

The operational risk management framework (i.e., the Framework) must define, describe, and classify operational risk and operational loss exposure. The Framework helps the board and managers understand the nature and complexities of operational risks inherent in the bank's products and services. The components of the Framework should be fully integrated into the bank's overall risk management plan. The Framework must be documented in the board of directors' approved policies.

Framework documentation, which is overseen by the board of directors and senior management, should:

- Describe reporting lines and accountabilities within the governance structure used to manage operational risks.
- Describe risk assessment tools.
- Describe the bank's risk appetite and tolerance.
- Describe risk limits.
- Describe the approved risk mitigation strategies (and instruments).
- With respect to inherent and residual risk exposures, describe the bank's methods for establishing risk limits and monitoring risk limits.
- Establish risk reporting processes and management information systems.
- Establish a common language or taxonomy of operational risk terms to create consistency of risk identification and management.

- Establish a process for independent review of operational risk.
- Require review of established policies and procedures.

Tools for Identifying and Assessing Operational Risk

LO 37.4: Describe tools and processes that can be used to identify and assess operational risk.

Tools that may be used to identify and assess operational risk include:

- **Business process mappings**, which do exactly that, map the bank's business processes. Maps can reveal risks, interdependencies among risks, and weaknesses in risk management systems.
- **Risk and performance indicators** are measures that help managers understand the bank's risk exposure. There are *Key Risk Indicators* (KRIs) and *Key Performance Indicators* (KPIs). KRIs are measures of drivers of risk and exposures to risk. KPIs provide insight into operational processes and weaknesses. Escalation triggers are often paired with KRIs and KPIs to warn when risk is approaching or exceeding risk thresholds.
- **Scenario analysis** is a subjective process where business line managers and risk managers identify potential risk events and then assess potential outcomes of those risks.
- **Measurement** involves the use of outputs of risk assessment tools as inputs for operational risk exposure models. The bank can then use the models to allocate economic capital to various business units based on return and risk.
- **Audit findings** identify weaknesses but may also provide insights into inherent operational risks.
- Analysis of **internal operational loss data**. Analysis can provide insight into the causes of large losses. Data may also reveal if problems are isolated or systemic.
- Analysis of **external operational loss data** including gross loss amounts, dates, amount of recoveries and losses at other firms.
- **Risk assessments**, or *risk self-assessments* (RSAs), address potential threats. Assessments consider the bank's processes and possible defenses relative to the firm's threats and vulnerabilities. *Risk Control Self-Assessments* (RCSA) evaluate risks before risk controls are considered (i.e., inherent risks). Scorecards translate RCSA output into metrics that help the bank better understand the control environment.
- **Comparative analysis** combines all described risk analysis tools into a comprehensive picture of the bank's operational risk profile. For example, the bank might combine audit findings with internal operational loss data to better understand the weaknesses of the operational risk framework.

Features of an Effective Control Environment

LO 37.5: Describe features of an effective control environment and identify specific controls that should be in place to address operational risk.

An effective control environment must include the following five components:

1. A control environment.

2. Risk assessment.

3. Control activities.

4. Information and communication.

5. Monitoring activities.

Senior managers should conduct top-level reviews of progress toward stated risk objectives, verify compliance of standards and controls, review instances of non-compliance, evaluate the approval system to ensure accountability, and track reports of exceptions to risk limits and management overrides and deviations from risk policies and controls. Managers should also ensure that duties are segregated and conflicts of interest are identified and minimized.

Specific controls that should be in place in the organization to address operational risk include:

- Clearly established lines of authority and approval processes for everything from new products to risk limits.
- Careful monitoring of risk thresholds and limits.
- Safeguards to limit access to and protect bank assets and records.
- An appropriately sized staff to manage risks.
- An appropriately trained staff to manage risks.
- A system to monitor returns and identify returns that are out of line with expectations (e.g., a product that is generating high returns but is supposed to be low risk may indicate that the performance is a result of a breach of internal controls).
- Confirmation and reconciliation of bank transactions and accounts.
- A vacation policy that requires officers and employees to be absent for a period not less than two consecutive weeks.

Managing Technology Risk and Outsourcing Risk

LO 37.6: Explain the Basel Committee's suggestions for managing technology risk and outsourcing risk.

Technology can be used to mitigate operational risks. For example, automated procedures are generally less prone to error than manual procedures. However, technology introduces its own risks. The Basel Committee recommends an integrated approach to identifying, measuring, monitoring, and managing technology risks.

Technology risk management tools are similar to those suggested for operational risk management and include:

- Governance and oversight controls.
- Policies and procedures in place to identify and assess technology risks.
- Written risk appetite and tolerance statements.
- Implement a risk control environment.
- Establish risk transfer strategies to mitigate technology risks.
- Monitor technology risks and violations of thresholds and risk limits.
- Create a sound technology infrastructure (i.e., the hardware and software components, data and operating environments).

Outsourcing involves the use of third parties to perform activities or functions for the firm. Outsourcing may reduce costs, provide expertise, expand bank offerings, and/or improve bank services. The board of directors and senior management must understand the operational risks that are introduced as a result of outsourcing. Outsourcing policies should include:

- Processes and procedures for determining which activities can be outsourced and how the activities will be outsourced.
- Processes for selecting service providers (e.g., due diligence).
- Structuring the outsourcing agreement to describe termination rights, ownership of data, and confidentiality requirements.
- Monitor risks of the arrangement including the financial health of the service provider.
- Implement a risk control environment and assess the control environment at the service provider.
- Develop contingency plans.
- Clearly define responsibilities of the bank and the service provider.

Key Concepts

LO 37.1

The Basel Committee on Banking Supervision defines operational risk as, "the risk of loss resulting from inadequate or failed internal processes, people, and systems or from external events."

The Basel Committee recognizes three common lines of defense used to control operational risks. These lines of defense are: (1) business line management, (2) independent operational risk management function, and (3) independent reviews of operational risks and risk management.

LO 37.2

The 11 fundamental principles of operational risk management suggested by the Basel Committee are:

1. The maintenance of a strong risk management culture led by the bank's board of directors and senior management.

2. The operational risk framework (i.e., the "Framework") must be developed and fully integrated in the overall risk management processes of the bank.

3. The board should approve and periodically review the Framework. The board should also oversee senior management to ensure that appropriate risk management decisions are implemented at all levels of the firm.

4. The board must identify the types and levels of operational risks the bank is willing to assume as well as approve risk appetite and risk tolerance statements.

5. Consistent with the bank's risk appetite and risk tolerance, senior management must develop a well-defined governance structure within the bank.

6. Operational risks must be identified and assessed by managers. Senior management must understand the risks, and the incentives related to those risks, inherent in the bank's business lines and processes.

7. New lines of business, products, processes, and systems should require an approval process that assesses the potential operational risks.

8. A process for monitoring operational risks and material exposures to losses should be put in place by senior management and supported by senior management, the board of directors, and business line employees.

9. Banks must put strong internal controls and risk mitigation and risk transfer strategies in place to manage operational risks.

10. Banks must have plans in place to survive in the event of a major business disruption. Business operations must be resilient.

11. Banks should make disclosures that are clear enough that outside stakeholders can assess the bank's approach to operational risk management.

LO 37.3

The board of directors and senior management must be engaged with operational risk assessment related to all 11 of the fundamental principles of operational risk management. The operational risk management framework must define, describe, and classify operational risk and operational loss exposure. The Framework must be documented in the board of directors approved policies.

LO 37.4

There are several tools that may be used to identify and assess operational risk. The tools include business process mappings, risk and performance indicators, scenario analysis, using risk assessment outputs as inputs for operational risk exposure models, audit findings, analyzing internal and external operational loss data, risk assessments, and comparative analysis.

LO 37.5

An effective control environment should include the following five components: (1) a control environment, (2) risk assessment, (3) control activities, (4) information and communication, and (5) monitoring activities.

LO 37.6

Technology can be used to mitigate operational risks but it introduces its own risks. The Basel Committee recommends an integrated approach to identifying, measuring, monitoring, and managing technology risks. Technology risk management tools are similar to those suggested for operational risk management.

Outsourcing involves the use of third parties to perform activities or functions for the firm. Outsourcing may reduce costs, provide expertise, expand bank offerings, and/or improve bank services. The board of directors and senior management must understand the operational risks that are introduced as a result of outsourcing.

Concept Checkers

1. Griffin Riehl is a risk manager at Bluegrass Bank and Trust, a small, independent commercial bank in Kentucky. Riehl has recently read the Basel Committee on Banking Supervision's recommendations for sound operational risk management and would like to put several controls in place. He would like to start with the three lines of defense suggested by the committee. Which of the following is not one of the three common "lines of defense" suggested by the Basel Committee for operational risk governance?
   A. Business line management.
   B. Board of directors and senior management risk training programs.
   C. Creating an independent operational risk management function in the bank.
   D. Conducting independent reviews of operational risks and risk management operations.

2. Garrett Bridgewater, a trader at a large commercial bank, has continued to increase his bonus each year by producing more and more profit for the bank. In order to increase profits, Bridgewater has been forced to increase the riskiness of his positions, despite the written risk appetite and tolerance statements provided to all employees of the bank. The bank seems happy with his performance so Bridgewater takes that as a sign of approval of his methods for improving profitability. Which of the following pairs of the 11 fundamental principles of risk management has the bank most clearly violated in this situation?
   A. Principle 1 (a strong risk management culture) and Principle 11 (the bank should make clear disclosures of operational risks to stakeholders).
   B. Principle 2 (develop an integrated approach to operational risk management) and Principle 7 (establish a rigorous approval process for new lines of business).
   C. Principle 3 (approve and review the operational risk framework) and Principle 4 (develop risk appetite and tolerance statements).
   D. Principle 5 (develop a well-defined governance structure) and Principle 6 (understand the risk and incentives related to risk inherent in the bank's business lines and processes).

3. Gary Hampton is providing descriptions of the operational risk management assessment tools, reporting lines, and accountabilities to the board of directors. Hampton is most likely working on:
   A. Framework documentation.
   B. A corporate operational risk function (CORF) handbook of operations.
   C. An outline of the fundamental principles of operational risk management.
   D. An open group operational framework diagram.

4. George Mathis works in risk analysis and management at a large commercial bank. He uses several tools to identify and assess operational risk. He has asked several business line managers to identify some risk events that would disrupt business. Each manager has also provided their thoughts on what would happen given worst case operational failures. The risk assessment tool Mathis is most likely using in this case is(are):
   A. risk indicators.
   B. comparative analysis.
   C. scenario analysis.
   D. business process mappings.

5. A risk management officer at a small commercial bank is trying to institute strong operational risk controls, despite little support from the board of directors. The manager is considering several elements as potentially critical components of a strong control environment. Which of the following is not a required component of an effective risk control environment as suggested by the Basel Committee on Banking Supervision?
   A. Information and communication.
   B. Monitoring activities.
   C. A functionally independent corporate operational risk function.
   D. Risk assessment.

Concept Checker Answers

1. **B** The three common "lines of defense" suggested by the Basel Committee on Banking Supervision and employed by firms to control operational risks are: (1) business line management, (2) an independent operational risk management function, and (3) independent reviews of operational risks and risk management.

2. **D** Based on the choices provided, the best match for the scenario is a violation of Principles 5 and 6. It is clear that the bank has not considered the incentives that are related to risk taking in the bank. Bridgewater has been given the risk appetite and tolerance statements but senior managers keep rewarding Bridgewater for high returns and seem to be ignoring the fact that they are the result of higher risks. Thus, there are incentives linked to increasing risk. The governance structure may or may not be well defined, but regardless, is not being adhered to.

3. **A** The operational risk management framework (i.e., the Framework) must define, describe, and classify operational risk and operational loss exposure. Hampton is likely working on Framework documentation. Framework documentation is overseen by the board of directors and senior management.

4. **C** Mathis is asking for managers to identify potential risk events, which he will use to assess potential outcomes of these risks. This is an example of scenario analysis. Scenario analysis is a subjective process where business line managers and risk managers identify potential risk events and then assess potential outcomes of those risks.

5. **C** A functionally independent corporate operational risk function is desirable in a bank but is not necessary for an effective control environment. This is especially true for a small bank, which might roll all risk management activities into one risk management group (i.e., not segregated by type of risk). An effective control environment should include the following five components: (1) a control environment, (2) risk assessment, (3) control activities, (4) information and communication, and (5) monitoring activities.

The following is a review of the Operational and Integrated Risk Management principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

Enterprise Risk Management: Theory and Practice

Topic 38

Exam Focus

Enterprise risk management (ERM) is the process of managing all of a corporation's risks within an integrated framework. This topic describes how ERM can be implemented in a way that enables a company to manage its total risk-return tradeoff in order to better carry out its strategic plan, gain competitive advantage, and create shareholder value. Key issues include why it may be optimal to hedge diversifiable risk and how to differentiate between core risks the firm should retain and noncore risks the firm should layoff. Also discussed is the determination of the optimal amount of corporate risk and the importance of ensuring that managers at all levels take proper account of the risk-return tradeoff. For the exam, understand the framework for developing and implementing ERM.

Creating Value With ERM

LO 38.1: Define enterprise risk management (ERM) and explain how implementing ERM practices and policies can create shareholder value, both at the macro and the micro level.

A business can manage its risks separately, one at a time, or all together in a cohesive framework. **Enterprise risk management** (ERM) is the process of managing all of a corporation's risks within an integrated framework.

The benefit of ERM is that a comprehensive program for managing risk allows the business to achieve its ideal balance of risk and return.

Macro Level

At the macro level, ERM allows management to optimize the firm's risk/return tradeoff. This optimization assures access to the capital needed to execute the firm's strategic plan.

The perfect markets view of finance implies that a company's cost of capital is unrelated to its diversifiable risk. Rather, the cost of capital is determined by the firm's **systematic risk** (also referred to as nondiversifiable, market, or beta risk). According to this view, efforts to hedge diversifiable risk provide no benefit to shareholders, who can eliminate this risk by diversifying their portfolios.

However, reducing diversifiable risk can be beneficial when markets are imperfect. Suppose a firm experiences a large and unexpected drop in its operating cash flow and does not have

funds sufficient to fund valuable investment opportunities. In perfect markets, the firm would be able to raise funds on fair terms to fund all of its value-creating projects. When markets are not perfect (i.e., investors' information about project values is incomplete), the firm may not be able to raise the needed funds on fair terms. This can lead to the "underinvestment problem," where the company passes up valuable strategic investments rather than raise equity on onerous terms. The inability to fund strategic investments on a timely basis can result in a permanent reduction in shareholder value, even if the cash shortfall is temporary. By hedging diversifiable risks, the company reduces the likelihood of facing the underinvestment problem. Thus, the primary function of corporate risk management is to protect the company's strategic plan by ensuring timely investment. The ability to carry out the strategic plan in a timely manner confers an advantage over competitors who are unable to do so.

Micro Level

In order for ERM to achieve the objective of optimizing the risk/return tradeoff, each project must be evaluated not only for the inherent risk of the project but also for the effect on the overall risk of the firm. Thus, ERM requires that managers throughout the firm be aware of the ERM program. This decentralization of evaluating the risk/return tradeoff has two components:

- Any managers evaluating new projects must consider the risks of the project in the context of how the project will affect the firm's total risk.
- Business units must be evaluated on how each unit contributes to the total risk of the firm. This gives the individual managers an incentive to monitor the effect of individual projects on overall firm risk.

There are three reasons why decentralizing the risk-return tradeoff in a company is important:

1. *Transformation of the risk management culture:* A consistent, systematic assessment of risks by all business units ensures that managers consider the impact of all important risks.

2. *Every risk is owned:* Because performance evaluations are based on risk, managers have an incentive to consider important risks in their decision making.

3. *Risk assessment by those closest to the risk:* Managers in the individual business units have the knowledge and expertise needed to assess and manage the risks of the business unit.

Development and Implementation

LO 38.2: Explain how a company can determine its optimal amount of risk through the use of credit rating targets.

LO 38.3: Describe the development and implementation of an ERM system, as well as challenges to the implementation of an ERM system.

In developing an ERM, management should follow this framework:

- *Determine the firm's acceptable level of risk.* The critical component of this determination is selecting the probability of financial distress that maximizes the value of the firm. Financial distress in this context means any time the firm must forego projects with positive net present values, due to inadequate resources. The likelihood of financial distress could be minimized by investing all funds into U.S. Treasury securities, but this should not be the firm's objective. The objective should be maximizing firm value by selecting an appropriate probability of distress. For many firms, the proxy used for measuring the probability of distress is the firm's credit rating assigned by external agencies. Thus, the firm may determine that the objective under ERM is to avoid a minimum credit rating below BBB. If the firm is currently rated AA, for example, the likelihood of falling below BBB can be estimated by average data supplied by the rating agency.
- *Based on the firm's target debt rating, estimate the capital (i.e., buffer) required to support the current level of risk in the firm's operations.* In other words, how much capital does the firm need to have (on hand or available externally) to ensure that it can avoid financial distress. A company with liquid assets sufficient to fund all of its positive NPV projects would not be exposed to the underinvestment problem when it encountered cash flow deficits. Thus, risk management can be viewed as a substitute for investing equity capital in liquid assets. Keeping a large amount of equity in the form of liquid assets is costly. Instead of maintaining a large liquid asset buffer, a company can institute a risk management program to ensure (at some level of statistical significance) that its operating cash flow will not fall below the level needed to fund valuable projects. That is, the firm can take actions to limit the probability of financial distress to a level that maximizes firm value. The goal of ERM is to optimize (not eliminate) total risk by trading off the expected returns from taking risks with the expected costs of financial distress.
- *Determine the ideal mix of capital and risk that will achieve the appropriate debt rating.* At this level of capital, the firm will be indifferent between increasing capital and decreasing risk.
- *Decentralize the risk/capital tradeoff by giving individual managers the information and the incentive they need to make decisions appropriate to maintain the risk/capital tradeoff.*

The implementation steps of ERM are as follows:

Step 1: *Identify the risks of the firm.* For many banks, risks are classified as falling into one of three categories: market, credit, or operational. Other financial institutions broaden the list to include asset, liability, liquidity, and strategic risks. Identification of risks should be performed both top-down (by senior management) and bottom-up (by individual managers of business units or other functional areas).

Step 2: Develop a consistent method to evaluate the firm's exposure to the risks identified above. If the methodology is not consistent, the ERM system will fail because capital will be mis-allocated across business units.

Implementation of an ERM system is challenging, and it is important that the entire organization supports the system. Thus, it is critical for all levels of the organization to understand how the system is designed and how it can create value. Monitoring the ERM system may be neglected due to its time-consuming nature. However, the inability to identify relevant risks on a regular basis could lead to corporate failures.

Economic Value vs. Accounting Value

Credit ratings are typically based on accounting data, combined with some level of subjective assessment by analysts. Economic value, as determined by management, may very well be a more accurate reflection of the true value of the firm.

In determining whether accounting value or economic value is more relevant, the firm must consider its objective. If the objective is to manage the probability of default, the question of how default is determined becomes important. If default is determined by failure to meet certain accounting measures (e.g., debt ratio, interest coverage), then accounting measures will be a critical component of meeting the objectives.

If the objective is to manage the present value of future cash flows, then economic measures may be more appropriate than accounting measurements that do not accurately capture economic reality. Management must consider that managing economic value may lead to more volatile accounting earnings, which may ultimately affect economic value as well.

Risk Aggregation

LO 38.4: Describe the role of and issues with correlation in risk aggregation, and describe typical properties of a firm's market risk, credit risk, and operational risk distributions.

Firms that use value at risk (VaR) to assess potential loss amounts will ultimately have three different VaR measures to manage. Market risk, credit risk, and operational risk will each produce their own VaR measures. The trick to accurately measuring and managing firm-wide risk, and in turn **firm-wide VaR**, is to understand how these VaR measures interact. Market risks will typically follow a normal distribution; however, the distributions for credit risks and operational risks are usually asymmetric in shape, due to the fat-tail nature of these risks.

Due to diversification effects of aggregating market, credit, and operational risk, firm-wide VaR will be less than the sum of the VaRs from each risk category. This suggests that the correlation among risks is some value less than one. It can be difficult to determine this correlation amount, so firms typically use average correlation values within their respective industry. However, firms should recognize that correlations can be influenced by firm-specific actions as well as external events such as a financial crisis.

Capital Allocation

LO 38.5: Distinguish between regulatory and economic capital, and explain the use of economic capital in the corporate decision making process.

Regulatory capital requirements may differ significantly from the capital required to achieve or maintain a given credit rating (**economic capital**). If regulatory requirements are less than economic capital requirements, then the firm will meet the regulatory requirements as part of its ERM objectives, and there will be no effect on the firm's activities.

However, if regulatory capital requirements are greater than economic capital requirements, then the firm will have excess capital on hand. If competitors are subject to the same requirements, this excess capital will amount to a regulatory tax. If competing firms are not subject to the excess capital requirement, they will have a competitive advantage.

Because regulatory capital requirements are typically based on accounting capital, rather than economic capital, a firm with economic values in excess of accounting values may be penalized, and may have to maintain higher amounts in liquid assets to cover the shortfall.

The economic capital of the firm must be put to productive use. If a firm accumulates excess economic capital that is not employed productively, investors will reduce the value of the firm. This reduction will be consistent with the failure of existing management to earn the cost of capital on the excess amount.

As a firm takes on new projects, the probability of financial distress increases. One way to offset this increased risk is to raise enough additional capital to bring the risk of financial distress back to the level that existed prior to the new project.

For example, assume that a firm has a value at risk (VaR) measure of $1 billion. As a result of a new expansion project, assume the VaR figure increases to $1.1 billion. In order to offset the risk of the new project, the firm would need to do the following:

1. Raise additional capital of $100 million.

2. Invest this additional capital without increasing the overall risk of the firm.

If the cost of the additional capital is 6%, and the new project is expected to last one year, then the new project would need to generate an additional $6 million to maintain the economic capital of the firm. Looked at another way, the expected benefit of the new project should be reduced by $6 million to compensate for the incremental risk to the firm.

These decisions regarding how the risk of new projects will affect the total risk of the firm are further complicated by the correlations of the expected returns of the projects. If two new projects are less than perfectly correlated, the incremental increase in total risk will be less. One way to account for any possible diversification benefits is to reduce the cost of capital of projects that are expected to have lower correlations with existing operations.

Risks to Retain and Risks to Layoff

Many risks can be hedged inexpensively with derivatives contracts. Examples include exposures to changes in exchange rates, interest rates, and commodities prices. Rather than face the risk that unexpected cash shortfalls due to these exposures might negatively affect the ability of the firm to carry out its strategic plan, the firm should hedge these exposures.

Other risks cannot be inexpensively hedged. These are risks where the firm's management either has an informational advantage over outsiders or the ability to manage the outcome of the risk-taking activity. A counterparty to a transaction that hedges such risks would require very high compensation to be willing to take on the transferred risks. The firm's business risks fall into this category.

The guiding principle in deciding whether to retain or layoff risks is the **comparative advantage** in risk bearing. A company has a comparative advantage in bearing its strategic and business risks, because it knows more about these risks than outsiders do. Because of this informational advantage, the firm cannot transfer these risks cost effectively. Moreover, the firm is in the business of managing these "core" risks. On the other hand, the firm has no comparative advantage in forecasting market variables such as exchange rates, interest rates, or commodities prices. These "noncore" risks can be laid off. By reducing noncore exposures, the firm reduces the likelihood of disruptions to its ability to fund strategic investments and increases its ability to take on business risks.

Key Concepts

LO 38.1

Enterprise risk management (ERM) is the process of managing all a corporation's risks within an integrated framework.

The macro benefit of ERM is that hedging corporate diversifiable risk improves management's ability to invest in value-creating projects in a timely manner and improves the firm's ability to carry out the strategic plan.

The micro benefit of ERM requires decentralizing risk management to ensure that each project's total risk is adequately assessed by project planners during the initial evaluation of the project. The two main components of decentralizing the risk-return tradeoff are consideration of the marginal impact of each project on the firm's total risk and a performance evaluation system that considers unit contributions to total risk.

LO 38.2

The goal of risk management is to optimize (not eliminate) total risk by trading off the expected returns from taking risks with the expected costs of financial distress. Financial distress in this case is defined as circumstances where the firm is forced to forego positive NPV projects.

LO 38.3

The conceptual framework of ERM is a four-step process:

- Determine the firm's risk appetite.
- Estimate the amount of capital needed to support the desired level of risk.
- Determine the optimal combination of capital and risk that achieves the target credit rating.
- Decentralize the management of risk.

LO 38.4

Due to diversification effects of aggregating market, credit, and operational risk, firm-wide VaR will be less than the sum of the VaRs from each risk category. This suggests that the correlation among risks is some value less than one.

LO 38.5

Regulatory capital requirements may differ significantly from the capital required to achieve or maintain a given credit rating (economic capital).

Because regulatory capital requirements are typically based on accounting capital, rather than economic capital, a firm with economic values in excess of accounting values may be penalized, and may have to maintain higher amounts in liquid assets to cover the shortfall.

The economic capital of the firm must be put to productive use. If a firm accumulates excess economic capital that is not employed productively, investors will reduce the value of the firm.

Concept Checkers

1. Reducing diversifiable risk creates value:
   A. only when markets are perfect.
   B. because it is costly for shareholders to eliminate diversifiable risk through their own actions.
   C. because reducing diversifiable risk mitigates the underinvestment problem that can occur when investors have imperfect information about the firm's projects.
   D. only when it results in a permanent reduction in cash flow.

2. Effective enterprise risk management includes all of the following except:
   A. centralized evaluation of every project's risk.
   B. a project is only accepted if its return is adequate after considering the cost of the project's contribution to total firm risk.
   C. the project's planners perform the initial evaluation of project risk.
   D. periodic evaluations of the performance of business units consider each unit's contribution to total risk.

3. The goal of enterprise risk management (ERM) can best be described as maximizing firm value by:
   A. eliminating the total risk of the firm.
   B. minimizing the total risk of the firm.
   C. optimizing the total risk of the firm.
   D. eliminating the probability of financial distress.

4. In determining the relative importance of economic value compared to accounting performance in its enterprise risk management program, a firm should:
   A. rely on accounting performance because it will be more accurate.
   B. rely on economic value because it will be more accurate.
   C. base its decision on the input of project-level managers.
   D. base its decision on the objective of the ERM program.

5. Which risk is least likely to be beneficial for a company to layoff?
   A. Currency exchange rate risk.
   B. Business risk.
   C. Commodities price risk.
   D. Interest rate risk.

Concept Checker Answers

1. **C** When markets are not perfect (i.e., investors' information about project values is incomplete), the firm may not be able to raise funds on fair terms. For a firm faced with an unexpected drop in operating cash flow, this can lead to the underinvestment problem, where the company passes up valuable strategic investments rather than raise equity on onerous terms. The inability to fund strategic investments can result in a permanent reduction in shareholder value even if the cash shortfall is temporary. Hedging diversifiable risk mitigates the underinvestment problem and creates value, even though shareholders can eliminate diversifiable risk at low cost by diversifying their portfolios.

2. **A** Central to ERM is the idea that a *decentralized* approach to the evaluation of project risks focuses managers throughout the firm on the importance of properly considering the risk and return implications of projects.

3. **C** The goal of ERM is to optimize the total risk of the firm. Eliminating total risk is not possible. Minimizing total risk would preclude accepting risky projects that would allow the firm to expand and maximize value. These risky projects will increase the probability of financial distress. The goal of ERM is to optimize the risk of distress relative to the potential returns from the risky projects.

4. **D** There are certain situations where either accounting values or economic values will more accurately reflect the firm's situation. The determining factor in choosing between economic values and accounting values is the objective of the program. For example, if the objective is maintaining a rating, based in large part on accounting numbers, then accounting numbers will assume more relative importance.

5. **B** A company has a comparative advantage in bearing its strategic and business risks because it knows more about these risks than outsiders do. The firm is in the business of managing these "core" risks. The firm has no comparative advantage in forecasting market variables such as exchange rates, interest rates, or commodities prices. These "noncore" risks can be laid off.

The following is a review of the Operational and Integrated Risk Management principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

Observations on Developments in Risk Appetite Frameworks and IT Infrastructure

Topic 39

Exam Focus

This topic discusses the concept of a risk appetite framework (RAF). For the exam, understand the elements and benefits of an RAF, and be familiar with best practices for an effective RAF. Also, be able to identify metrics that can be monitored as part of an effective RAF. Finally, understand the elements and benefits of a robust risk data infrastructure as well as best practices relating to data aggregation.

Risk Appetite Framework

LO 39.1: Describe the concept of a risk appetite framework (RAF), identify the elements of an RAF, and explain the benefits to a firm of having a well-developed RAF.

A **risk appetite framework** (RAF) is a strategic decision-making tool that represents the firm's core risk strategy. It sets in place a clear, future-oriented perspective of the firm's target risk profile in a number of different scenarios and maps out a strategy for achieving that risk profile. It also specifies which types of risk the firm is willing to take and under what conditions as well as which types of risk the firm is unwilling to take.

An RAF should start with a risk appetite statement that is essentially a mission statement from a risk perspective. This statement should cover some or all of the following elements:

- Desired business mix and balance sheet composition (i.e., capital structure—trade-off between debt and equity).
- Risk preferences (i.e., how much credit or market risk to take on or hedge)
- Acceptable trade-off between risk and reward.
- Acceptable limits for volatility (based on standard deviation).
- Capital thresholds (i.e., regulatory and economic capital).
- Tolerances for post-stress losses.
- Target credit ratings.
- Optimum liquidity ratios.

The benefits of a well-developed RAF are as follows:

- It improves a firm's strategic planning and tactical decision-making.
- The inherent flexibility allows firms to adapt to market changes, especially if appropriate opportunities arise that require adjustments to the RAF.

- It assists firms in preparing for the unexpected; requires business line strategy reviews and maintains an open dialogue regarding the management of unexpected economic or market events in particular geographies or products.
- It focuses on the future and sets expectations regarding the firm's consolidated risk profile after performing relevant stress tests and scenario analyses. Thus, it helps the firm set up a plan for risk taking, loss mitigation, and use of contingency measures.

Developing and Implementing an Effective RAF

LO 39.2: Describe best practices for a firm's Chief Risk Officer (CRO), Chief Executive Officer (CEO), and its board of directors in the development and implementation of an effective RAF.

Chief Risk Officer (CRO) Best Practices

Board members involved with risk issues should be able to directly contact the CRO and engage in frequent communication about on-going key risk issues. A best practice could be to create a board risk committee that is directly involved in performance review and compensation decisions regarding the CRO. A strong alliance between the CRO (risk management function) and the CFO (budgetary considerations) is key to spreading the use of the RAF throughout the organization. Specifically, a best practice would be for the CRO and CFO to report to the board at every meeting by commenting on the firm's risk profile in comparison to the RAF. The CRO discussion could be broad and strategic in nature, and the CFO discussion could discuss financial impacts.

Chief Executive Officer (CEO) Best Practices

The CEO should strongly support the RAF and refer/use it to support challenging risk and strategic decisions. The willingness of the CEO to give the CRO the final word on many risk decisions is a best practice since it strengthens the importance of the risk management function. Where any instances of non-compliance with the RAF exist, a best practice would be for the CRO and/or the CEO to advise the board of directors on the corrective measures that will be undertaken.

Board of Directors (Board) Best Practices

The board needs to spend a considerable amount of time conveying the firm's risk appetite statement throughout the firm to ensure it is properly implemented. In challenging management to operate the firm in a way that is congruent with the RAF, the board must focus on strategic and forward-looking issues rather than dwelling on past actions. A best practice would be for the board to state its expectations to management in advance so that management can establish appropriate strategic plans.

When a board challenges management and requires a thorough vetting of the RAF, the end product is more complete and relevant. A best practice is to have the active involvement of the board with senior management in continually revising the RAF until everyone

is satisfied. Additionally, another best practice is the development of a concrete way of assessing when the RAF needs to be amended to reflect a changing environment.

With regard to technical knowledge of members, there should be a sufficient balance in board composition to ensure all members have a reasonable and congruent understanding of the firm's risks and to avoid situations where there are marked divisions between "experts" and "non-experts." A best practice is to provide detailed technical training to board members on relevant concepts. Additionally, requiring cross-membership amongst the major committees helps ensure that those functions have members with a strong technical base. The training and cross-membership practices should serve as supplements to existing expertise.

Boards must be proactive in stating the nature and frequency of the information they need. As a best practice, reporting to the board should be thorough and broad in scope and not overly simplified. Additionally, communication from management should include a business aspect and not be focused on just technical aspects. Finally, as another best practice, the board should be willing to push back to management if they feel the information provided is not sufficient for their needs.

Reputation risk needs to have a significant amount of the board's attention. As a best practice, the board should set up a reputational risk committee to analyze marketplace changes and approve transactions on the basis of geography or product line. Attempting qualitative measures of reputation risk should also be done via monitoring industry headlines and reporting trends to the board as well as hiring external parties to conduct relevant surveys.

Using RAF to Manage Business Lines

LO 39.3: Explain the role of an RAF in managing the risk of individual business lines within a firm, and describe best practices for monitoring a firm's risk profile for adherence to the RAF.

Generally speaking, the RAF helps to ensure that each business line's strategies are congruent with the firm's desired risk profile. The various business line managers each submit a medium-term business plan to senior management and/or the board to determine if it is consistent with the RAF. Such determinations are often made with stress tests or scenario analyses. Afterward, the RAF will set the risk limits allocated to each business line based on its desired risk profile.

Additionally, the RAF considers the integrated nature of the business lines within the firm. For example, the RAF can help determine how much a given business line's medium-term business plans has to be amended in order to allow another business line's proposal to be approved. In other words, there may be some borrowing of the risk appetite allotment from a business line in order to take advantage of the current opportunity in another business line. Familiarity with the RAF by business line managers would dramatically decrease the number of plans that fall well outside acceptable bounds. A clear RAF assists the firm in preventing risk appetite drift when economic conditions change.

RAF Metrics for Monitoring Risk Profile

Examples of metrics that can be monitored as part of an effective RAF are as follows:

- Capital targets (economic capital, tangible common equity, total leverage) or capital-at-risk amounts.
- Liquidity ratios, terms, and survival horizons.
- Net interest income volatility or earnings-at-risk calculations.
- Value at risk (VaR) limits.
- Risk sensitivity limits.
- Risk concentrations by internal and/or external credit ratings.
- Expected loss ratios.
- The firm's own credit spreads.
- Asset growth ceilings by business line or exposure type.
- Performance of internal audit ratings.
- Economic value added.
- Post-stress-test targets for capital, liquidity, and earnings.

It is important to ensure that the metrics used to monitor risk are appropriate to the users of the information. Therefore, the risk metrics should be divided into classes, depending on who is receiving the information within the firm. For example:

- Directors should receive high-level metrics (less detail) that reflect the firm's key risks.
- CEO, CFO, CRO should receive more detailed metrics than directors.
- Business line leaders should receive very detailed metrics, especially in relation to their respective business lines.

Risk Data Infrastructure

LO 39.4: Explain the benefits to a firm from having a robust risk data infrastructure, and describe key elements of an effective IT risk management policy at a firm.

A benefit of a robust risk data infrastructure is the ability to aggregate timely and accurate data to report on credit, market, liquidity, and operational risks. This, in turn, allows management to make proper decisions regarding the firm's strategy, risk appetite, and risk management during periods of constant and frequent changes. Another benefit is the ability to sufficiently document and convey the firm's risk reporting requirements. Such requirements include: specific metrics, data accuracy expectations, element definitions, time frames, supervisory expectations, and regulatory reporting requirements.

Key elements of an effective IT risk management policy at a firm are described as follows:

- Clearly defined standards and internal risk reporting requirements to ensure a proper IT infrastructure and internal reporting.
- Sufficient funding is provided to develop IT systems for the purpose of internal risk reporting; they compete equally with proposals that are revenue generating, for example.
- Assessing IT infrastructure and capacity prior to approving new products.
- Post-implementation reviews of IT systems performed anywhere from 6–18 months afterward as a check that the systems meet the risk personnel's needs.

- The level of governance for outsourced IT activities is the same as if they were done in-house. There are no impediments to implementation or access to data due to outsourcing.
- The existence of effective project management offices (PMOs) to ensure that timelines and deliverables are met. Specifically, one person is in charge of the PMO, which seems to result in stronger coordination and communication between project staff.
- There is a data administrator as well as a data owner, and the data owner must ensure a sufficiently high level of data accuracy, integrity, and availability. This helps to ensure that IT projects are meeting the users' needs.
- The board is able to implement relevant internal audit programs to allow for periodic reviews of data maintenance processes and functions. The monitoring could be continuous or specific to a product or business line. This would allow for the quick correction of any weaknesses detected by internal audit.

Poor or Fragmented IT Infrastructure

LO 39.5: Describe factors that can lead to poor or fragmented IT infrastructure at an organization.

There are five major factors to consider with regard to poor or fragmented IT infrastructures.

1. *No common understanding of long-term business strategy between business lines and IT management.* This factor often results due to internal competition for funding, thereby not permitting important IT infrastructure projects to be completed.

2. *Management only makes decisions based on short-term profits.* As a result of this factor, many IT infrastructure projects are scaled back, delayed, or eliminated.

3. *Significant turnover in important IT roles within the firm.* This factor has resulted in delays in completing IT projects.

4. *Insufficient data governance and insufficient data management plan within the firm.* This factor results in inconsistency across business lines in how to upgrade systems; this is costly if the systems end up being incompatible because of the inconsistencies.

5. *Merger and acquisition activities.* This factor results in multiple systems running simultaneously within the recently merged firm. Data aggregation across products and business lines becomes a significant challenge.

Data Aggregation Best Practices

LO 39.6: Explain the challenges and best practices related to data aggregation at an organization.

The existence of several IT systems being operated simultaneously within a firm results in a lack of integrated IT systems. This, in turn, requires a significant amount of manual data entry to allow for proper aggregation of risk data. Best practices related to data aggregation at an organization are explained as follows:

- To increase efficiency and accuracy, minimize the amount of manual intervention and manual data manipulation (i.e., spreadsheets) by automating the risk data aggregation process.
- Aggregated risk data needs to be accurate, timely, and comprehensive in order to have value. Therefore, there must be standards, cutoff times, and timelines regarding the production of internal risk reports.
- Single platform centralized databases with single identifiers and/or consistent naming conventions could allow for the timely retrieval of multiple records of risk data across the firm. They also permit data segmentation when required to produce specific data (i.e., risk concentrations).
- Create data warehouses that will take information from various subsystems and store them in a warehouse. The data is then filtered and reorganized so that customized reports can be created using specific data from the warehouse.
- Automated reconciliation will reduce the risk of manual errors and incomplete information. For example, off-balance sheet data should not be omitted.
- Periodic reconciliation of risk and financial data will ensure the accuracy and proper operation of the IT system.
- For merger and acquisition transactions, ensuring that legacy IT systems are integrated into the chosen IT system as soon as possible.
- When obtaining approvals for new IT purchases, involve the appropriate technical staff to ensure that the existing systems can process and aggregate data from these new items.

Key Concepts

LO 39.1

A risk appetite framework (RAF) sets in place a clear, future-oriented perspective of the firm's target risk profile in a number of different scenarios and maps out a strategy for achieving that risk profile. An RAF should start with a risk appetite statement that is essentially a mission statement from a risk perspective. Benefits of a well-developed RAF include assisting firms in preparing for the unexpected and greatly improving a firm's strategic planning and tactical decision-making.

LO 39.2

The chief risk officer (CRO) should be easily available to the board of directors (board) and there should be a strong alliance between the CRO and the chief financial officer (CFO).

The chief executive officer (CEO) should strongly support the RAF and give the CRO the final word on risk decisions.

The board should: be willing to challenge management to operate the firm consistent with the RAF, actively work with senior management to continually revise the RAF, have sufficient technical and business understanding of the risks facing the firm, be proactive in stating the nature and frequency of the information they need, and set up a reputational risk committee.

LO 39.3

The RAF helps to ensure that each business line's strategies are congruent with the firm's desired risk profile. It also considers the integrated nature of the business lines within the firm.

Many metrics can be monitored as part of an effective RAF. Risk metrics should be divided into classes, depending on who is receiving the information within the firm.

LO 39.4

A robust data infrastructure results in management being able to make proper decisions regarding a firm's strategy, risk appetite, and risk management. Additionally, it allows for the ability to sufficiently document and convey the firm's risk reporting requirements.

Key elements of an effective IT risk management policy include: clearly defined standards and internal risk reporting requirements, sufficient funding to develop IT systems, assessing IT infrastructure and capacity prior to approving new products, timely post-implementation reviews of IT systems, and sufficient governance for outsourced IT activities.

LO 39.5

Poor or fragmented IT infrastructures result from a lack of common understanding of long-term business strategies between business lines and IT management, managers thinking only about short-term profits, significant turnover in IT roles, insufficient data governance, and merger and acquisition activities.

LO 39.6

The lack of integrated IT systems is the major challenge related to data aggregations. Many best practices regarding data aggregations exist including: minimizing the amount of manual data processes, using single platform centralized databases, creating data warehouses, automated and periodic data reconciliations, and timely integration of legacy IT systems.

Concept Checkers

1. Which of the following statements regarding the risk appetite framework (RAF) is correct?
   A. The RAF represents the firm's core risk strategy.
   B. The RAF should be amended to take advantage of all profitable opportunities.
   C. The RAF focuses on which risks the firm is willing to take and under what conditions.
   D. The RAF begins with the risk appetite statement that contains many elements, including examining the composition of the income statement.

2. As a best practice, which of the following members of senior management should have the final word on significant risk decisions at a firm?
   A. Chief executive officer.
   B. Chief financial officer.
   C. Chief operating officer.
   D. Chief risk officer.

3. Which of the following statements regarding the role of a risk appetite framework (RAF) in managing the risk of individual business lines within a firm is correct?
   A. Individual business lines may collectively cause the firm's RAF to drift when market conditions change.
   B. Sensitivity analysis is a robust tool to assist senior management and/or the board to determine consistency with the RAF.
   C. Each individual business line's risk appetite allotment according to the RAF is independent of the others to ensure objectivity in the process.
   D. The business line managers submit long-term business plans to senior management and/or the board to determine if they are consistent with the RAF.

4. Which of the following statements is incorrect regarding the key elements of an effective IT risk management policy?
   A. Having a single person in charge of the project management office.
   B. Comparable funding for IT projects and revenue-generating projects.
   C. Post-implementation reviews of IT systems at least 24 months after implementation.
   D. Outsourced and in-house IT activities being subjected to the same level of monitoring.

5. Which of the following items is a best practice related to data aggregation at an organization?
   A. Integrating legacy IT systems into the new IT system immediately.
   B. The use of one master spreadsheet to accumulate all of the data in one place.
   C. Periodic manual reconciliations to reduce the risk of errors and incomplete information.
   D. Allowing individual departments as much time as they require to produce internal reports that are accurate, timely, and comprehensive.

Concept Checker Answers

1. **A** The RAF represents the firm's core risk strategy. The RAF does not necessarily need to be amended every time there is a profitable opportunity; doing so would cause the RAF to lose its value. The RAF also focuses on which risks the firm is unwilling to take. The risk appetite statement would not likely include an examination of the composition of the income statement; it would more likely be the balance sheet (i.e., debt, equity).

2. **D** The willingness of the CEO to give the CRO the final word on many risk decisions is a best practice, which has strengthened the importance of the risk management function.

3. **A** Individual business lines may collectively cause the firm's RAF to drift when market conditions change. Sensitivity analysis only examines one change in a variable at a time. More robust tools would be stress tests and scenario analyses, for example. Each business line's risk appetite allotment according to the RAF may be amended if another business line encounters an opportunity that requires more capital. The business line managers submit medium-term business plans to senior management and/or the board.

4. **C** Post-implementation reviews should be performed 6–18 months after implementation; 24 months or more would likely be too long. Having one person in charge of the project management office seems to have resulted in stronger coordination and communication between project staff.

5. **A** For merger and acquisition transactions, it is best that legacy IT systems are integrated into the chosen IT system as soon as possible. Spreadsheets are a form of manual data manipulation and, because they are not automated, they would not be a best practice. Automated reconciliations should be performed, not manual. One of the key points about internal risk reports is that they should be produced on a timely basis, therefore, there must be standards, cutoff times, and timelines regarding their production.

The following is a review of the Operational and Integrated Risk Management principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

Information Risk and Data Quality Management

Topic 40

Exam Focus

This topic is a qualitative examination of data quality issues. Organizations must understand the risks involved with data issues and be able to identify ways to protect one of their most valuable resources, their data. For the exam, focus on the important features of acceptable data as well as details surrounding data quality scorecards.

Poor Data Quality

The following is a list of negative impacts on a business from poor data quality.

Financial impacts:

- Businesses may experience lower revenues (e.g., lost sales), higher expenses (e.g., penalties, re-work costs), and lower cash flows as a result of inaccurate or incomplete data.

Confidence-based impacts:

- Managers may make incorrect business decisions based on faulty data.
- Poor forecasting may result due to input errors.
- Inaccurate internal reporting may occur with unreliable information.

Satisfaction impacts:

- Customers may become dissatisfied when the business processes faulty data (e.g., billing errors).
- Employees may become dissatisfied when they are unable to properly perform their job due to flawed data.

Productivity impacts:

- Additional (corrective) work may be required, thereby reducing production output.
- Delays or increases in processing time.

Risk impacts:

- Underestimating credit risks due to inaccurate documentation, thereby exposing a lender to potential losses (e.g., Basel II Accords for quantifying credit risk).
- Underestimating investment risk, thereby exposing an investor to potential losses.

Compliance impacts:

- A business may no longer be in compliance with regulations (e.g., Sarbanes-Oxley) if financial reports are inaccurate.

Data Errors

LO 40.1: Identify the most common issues that result in data errors.

The most common data issues that increase risk for an organization are as follows:

- Data entry errors.
- Missing data.
- Duplicate records.
- Inconsistent data.
- Nonstandard formats.
- Complex data transformations.
- Failed identity management processes.
- Undocumented, incorrect, or misleading metadata (description of content and context of data files).

From a financial perspective, such data errors (accidental or not) may lead to inconsistent reporting, incorrect product pricing, and failures in trade settlement.

Examples of risks arising out of data errors include:

- Fraudulent payroll overpayments to fictitious employees or those who are no longer employed by the firm.
- Underbilling for services rendered.
- Underestimating insurance risk due to missing and inaccurate values (e.g., insured value).

Acceptable Data

LO 40.2: Explain how a firm can set expectations for its data quality and describe some key dimensions of data quality used in this process.

A fundamental step in managing risks due to flawed data would be to set user expectations for data quality and then establish criteria to monitor compliance with such expectations. In order to define and measure these expectations, they can be categorized into key dimensions of data quality. The important (but not complete) set of dimensions that characterize acceptable data include accuracy, completeness, consistency, reasonableness, currency, and uniqueness.

Accuracy

The concept of accuracy can be described as the degree to which data correctly reflects the real world object. Measurement of accuracy can occur by manually comparing the data to an authoritative source of correct information—for example, the temperature recorded in a thermometer compared to the real temperature.

Completeness

Completeness refers to the extent to which the *expected* attributes of data are provided. There may be mandatory and optional aspects of completeness. For example, it may be mandatory to have a customer's primary phone number, but if the secondary phone number (optional) is not available, then the data requirement for the phone number is still considered complete.

Note that although data may be complete, it may not necessarily be accurate. For example, customers may have moved and their mailing addresses may not have been updated yet.

Consistency

Consistency refers to reasonable comparison of values between multiple data sets. The concept of consistency is broad and could require that data values from each data set do not conflict (e.g., a bank account is closed but the statement still shows account activity) or that they meet certain pre-defined constraints.

Note that consistency does not necessarily imply accuracy.

There are three types of consistency:

1. *Record level*: consistency between one set of data values and another set within the same record.

2. *Cross-record level*: consistency between one set of data values and another set in different records.

3. *Temporal level*: consistency between one set of data values and another set within the same record at different points in time.

Reasonableness

Reasonableness refers to conformity with consistency expectations. For example, the income statement value for interest expense should be consistent or within an acceptable range when compared to the corresponding balance sheet value for long-term debt.

Currency

Currency of data refers to the lifespan of data. In other words, is the data still considered relevant and useful, given that the passage of time will gradually render it less current and less correct? Measurement of currency would consist of determining the frequency in which the data needs to be updated, and determining whether the existing data is still up-to-date.

Uniqueness

Uniqueness of data is tied into the data error involving duplicate records. Uniqueness suggests that there can only be one data item within the data set. For example, within a

client list, there should only be one Mr. Jack Lee with a date of birth of January 1, 1970 living at 1234 Anywhere Street in New York City.

Operational Data Governance

LO 40.3: Describe the operational data governance process, including the use of scorecards in managing information risk.

Operational data governance refers to the collective set of rules and processes regarding data that allow an organization to have sufficient confidence in the quality of its data.

Specifically, a data governance program should exist that clarifies the roles and responsibilities in managing data quality. A **data quality scorecard** could be used to monitor the success of such a program.

In short, operational data governance aims to detect data errors early on and then set into motion the steps needed to sufficiently deal with the errors on a timely basis. As a result, there should be minimal or no subsequent impact on the organization.

Data Quality Inspection vs. Data Validation

Data validation is a one-time step that reviews and assesses whether data conforms to defined business specifications. In contrast, **data quality inspection** is an on-going set of steps aimed to:

1. reduce the number of errors to a tolerable level,
2. spot data flaws and make appropriate adjustments to allow data processing to be completed, and
3. solve the cause of the errors and flaws in a timely manner.

The goal of data quality inspection is to catch issues early on before they have a substantial negative impact on business operations.

Data Quality Scorecard

A **base-level metric** is straightforward in that it is measured against clear data quality criteria. It is relatively easy to quantify whether the criteria is met in terms of arriving at a data quality score.

In contrast, a **complex metric** is a combined score that could be a weighted average of several different metrics (customized to the specific user(s)). Such a combined metric allows for a qualitative reporting of the impact of data quality on the organization. A data quality scorecard could report the metric in one of three ways: by issue, by business process, or by business impact.

Complex Metric Scorecard Viewpoints

Data quality issues view:

- Considers the impact of a specific data quality problem over multiple business processes.
- The scorecard shows a combined and summarized view of the impacts for each data problem. By going into more detail, one can obtain further information on the sources of data problems. This allows for prioritization in terms of solving individual problems.

Business process view:

- For each business process, the scorecard has complex metrics that quantify the impact of each data quality problem.
- It allows for the ability to determine exactly where in the business process the data problem is originating. This will assist in solving the problem efficiently.

Business impact view:

- The scorecard provides a high-level understanding of the risks embedded in data quality problems (i.e., a combined and summarized view). It considers various data quality problems that occur in various business processes.
- By going into more detail, one can identify the business processes where the problems occur. An even more detailed examination will reveal the specific problems within each business process.

Motivation

Business managers may wish to take advantage of an opportunity to assess the relationship between the impacts of flawed data versus the pre-defined parameters of acceptable data quality. Such an assessment could occur with a data quality scorecard, with data being measured against the benchmark (acceptable data quality). The scorecard, therefore, serves as a strong management technique if it can summarize important organizational information as well as provide warning signs to management when corrective actions are required.

Mechanics

Regardless of the preferred view, a data quality scorecard is comprised of a hierarchy of base-level and complex metrics that tie into different levels of accountability within the organization. With regard to metrics, the same measurement might be used in different contexts, which allows for different error tolerances and weights. Finally, scorecards can be customized to present varying levels of detail depending on the intended user(s).

Key Concepts

LO 40.1

Data errors (e.g., missing data, inconsistent data, nonstandard formats) whether they are accidental or not, may lead to inconsistent reporting, incorrect product pricing, or failures in trade settlement.

LO 40.2

Key dimensions that characterize acceptable data include: accuracy, completeness, consistency, reasonableness, currency, and uniqueness.

LO 40.3

Operational data governance refers to the collective set of rules and processes regarding data that allow an organization to have sufficient confidence in the quality of its data.

Three different viewpoints regarding scorecards include: data quality issues view, business process view, and business impact view.

Data quality scorecards serve as a strong management technique if they are able to summarize important organizational information as well as provide warning signs to management when corrective actions are required.

Concept Checkers

1. Ryan Vail is a corporate manager who recently made a series of incorrect business decisions as a result of faulty data obtained internally. Which of the following negative business impacts best describes his incorrect decisions?
   A. Compliance impact.
   B. Confidence-based impact.
   C. Financial impact.
   D. Risk impact.

2. Data consistency is important to ensure that there are no clear conflicts in data values between data sets. Which of the following types of data consistency refers to consistency between one set of data values and another set of data values in different records?
   A. Record level.
   B. Temporal level.
   C. Cross-record level.
   D. Cross-temporal level.

3. Which of the following data issues is least likely to increase risk for an organization?
   A. Duplicate records.
   B. Data normalization.
   C. Nonstandard formats.
   D. Data transformations.

4. Which of the following statements regarding data quality inspection is correct? It attempts to:
   A. catch errors early in the process.
   B. reduce the number of errors to zero.
   C. solve the cause of any errors immediately.
   D. review and assess whether data conforms with defined business specifications.

5. Which of the following viewpoints regarding data quality scorecards is best described as providing a high-level understanding of the risks embedded in data quality problems?
   A. Business impact view.
   B. Business process view.
   C. Data quality issues view.
   D. Data process issues view.

Concept Checker Answers

1. **B** An example of a confidence-based (negative) impact would be a manager who makes incorrect business decisions based on faulty data.

2. **C** Record level consistency is consistency between one set of data values and another set within the same record. Cross-record level consistency is consistency between one set of data values and another set in different records.

3. **B** Data normalization is a process to better organize data in order to minimize redundancy and dependency, so it is least likely to increase risk. All of the other data issues are likely to increase risk, especially complex data transformations.

4. **A** Data quality inspection is intended to catch issues early on before they have a substantial negative impact on business operations. The idea is to reduce the number of errors to a tolerable level, not necessarily to zero. In addition, it aims to solve the cause of the errors in a timely manner, not necessarily immediately.

5. **A** With the business impact view, the scorecard provides a high-level understanding of the risks embedded in data quality problems (i.e., a combined and summarized view). It considers various data quality problems that occur in various business processes.

The following is a review of the Operational and Integrated Risk Management principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

OpRisk Data and Governance

Topic 41

Exam Focus

This topic discusses the seven level 1 categories of operational risk (OpRisk) events defined in Basel II and describes level 2 examples of operational risk events for each category. For the exam, understand how the collection and reporting of loss data, the risk control self assessment (RCSA), identification of key risk indicators (KRIs), and scenario analysis are all important elements of a firm's OpRisk process. Also, be familiar with the OpRisk profiles across various financial sectors with emphases on the highest frequency percentages and severity percentages. Finally, be prepared to describe the typical progression through four organizational risk designs for large firms.

Event-Driven Risk Categories

LO 41.1: Describe the seven Basel II event risk categories and identify examples of operational risk events in each category.

Basel II provides seven categories of level 1 **loss events** that most firms have adopted to meet their own operational risk (OpRisk) framework requirements. OpRisk models are concerned with identifying and mitigating operational risks of the firm that are a function of people, systems, and external events. The seven Basel II event risk categories are described in Figure 1 and are intended to capture all potential operational risks. Every loss event should be mapped to the risk event categories outlined in the firm's operational risk management policies and procedures. However, some loss events may fall under more than one category.

It is important to recognize that the severity and frequency of losses can vary dramatically among the categories. For example, loss events are small but occur very frequently in the *Execution, Delivery, and Process Management* category. Whereas, losses are much less frequent but typically have a large dollar amount in the *Clients, Products, and Business Practices* category as these loss events commonly arise from substantial litigation suits.

The modeling of loss event data differs for each category. Thus, it is important to make sure every event is placed in the appropriate group. When assigning loss events, consistency is more important than accuracy. Effective operational risk management requires that similar events are consistently categorized the same way. If mistakes are made classifying risks in past years it will impact the risk management control process and reporting to regulators. In order to properly classify risks, it is important for the firm to perform a comprehensive risk mapping exercise that details every major process of the firm. The process of identifying and classifying risks is commonly referred to as **OpRisk taxonomy**.

Figure 1: Level 1 Categories of Operational Risk Events

Event Category	*Definition*
Execution, Delivery, and Process Management	Losses from failed transaction processing or process management from relations with trade counterparties and vendors.
Clients, Products, and Business Practices	Losses arising from unintentional or negligent failures to meet a professional obligation to specific clients (including fiduciary and suitability requirements) or from the nature or design of a product.
Business Disruption and System Failures	Losses arising from disruption of business or system failures.
Internal Fraud	Losses due to acts intended to defraud, misappropriate property, or circumvent regulations, the law, or company policy.
External Fraud	Losses due to acts intended to defraud, misappropriate property, or circumvent the law, by a third party.
Employment Practices and Workplace Safety	Losses arising from acts inconsistent with employment, health, or safety laws or agreements, from payment of personal injury claims, or from diversity/discrimination events.
Damage to Physical Assets	Losses arising from loss or damage to physical assets from natural disaster or other events such as vandalism or terrorism.

Source: Basel Committee on Banking Supervision, Annex 9, *Basel II: International Convergence of Capital Measurement and Capital Standards: A Revised Framework, 2006.*

Each of these seven level 1 categories identified in Figure 1 is then further broken down into a level 2 subcategory. As mentioned previously, the first two event types in Figure 1 have a higher frequency and severity of losses. Thus, it should not be surprising that there are more level 2 subcategories for these two event types. The level 2 categories help to further classify the type of loss event. Figure 2 identifies the six level 2 categories for the event type identified in level 1 as *Execution, Delivery, and Process Management (EDPM)*.

For financial firms, the EDPM category typically has the highest frequency of occurrence compared to the other categories. Business units in financial firms often deal with large numbers and executions of transactions. Due to the large volume of transactions on a daily basis, miscommunications and data-entry errors are common. For example, in the futures market, FX transactions are typically very large in order to compensate for the low margins of this product line. Errors in finalizing a transaction even for a few days can result in large losses as counterparties will require compensation for the use of funds. Identifying where the errors occur and the number of occurrences is necessary for managing these OpRisks.

Figure 2: Execution, Delivery, and Process Management (Level 1)

Level 2 Event Category	*Examples*
Transaction Capture, Execution, & Maintenance	Data entry, miscommunication, delivery failure, and accounting errors
Monitoring & Reporting	Mandatory reporting failure, inaccurate external report of loss incurred
Customer Intake & Documentation	Missing client permissions, incomplete documents
Customer/Client Account Management	Unapproved access, incorrect client records with loss incurred, negligent loss
Trade Counterparties	Non-client counterparty misperformance or disputes
Vendors & Suppliers	Outsourcing or vendor disputes

Source: Basel Committee on Banking Supervision, Annex 9, *Basel II: International Convergence of Capital Measurement and Capital Standards: A Revised Framework, 2006.*

The second Basel II category listed in Figure 1 is *Clients, Products, and Business Practices (CPBP).* The most common type of loss events in this category arise from disagreements between clients and counterparties, as well as regulatory fines for negligent business practices and advisory fiduciary duties. Litigation cases are high in the United States and the severity of losses is very high even though the frequency of loss events is typically less than the EDPM category. Figure 3 provides the level 2 subcategories with examples for the CPBP category.

Figure 3: Clients, Products, and Business Practices (Level 1)

Level 2 Event Category	*Examples*
Suitability, Disclosure, & Fiduciary	Fiduciary violations, disclosure issues, privacy violation, account churning
Improper Business or Market Practices	Antitrust, improper trade or market practices, insider trading, market manipulation
Product Flaws	Product defects, model errors
Selection, Sponsorship, & Exposure	Client guidelines failure or excess client limits
Advisory Activities	Advisory performance disputes

Source: Basel Committee on Banking Supervision, Annex 9, *Basel II: International Convergence of Capital Measurement and Capital Standards: A Revised Framework, 2006.*

The *Business Disruption and System Failures (BDSF)* category is far less common than the first two Basel II categories. A system crash will result in substantial losses for a firm, but most of these losses would be categorized under the EDPM category. The following example illustrates a type of BDSF loss. Suppose a bank's funding system crashes early in the day and is not back online until after the money markets are already closed after 4:00 p.m. EST. Due to this system crash, the bank needs to fund an extra $30 billion for the day's activities. To do so, the bank must make special arrangements with counterparties at a much higher cost than the daily average funding cost. Basel II defines failed activity examples leading to loss events in the BDSF category as hardware, software, telecommunications, and utility outage.

The Basel II level 1 *External Fraud* category has only two subcategories: (1) theft and fraud and (2) systems security. Examples of activities that are classified under the theft and fraud subcategory are theft, forgery, and check kiting. Examples of activities that are classified under the systems security subcategory are hacking damage and theft of information with monetary losses.

The Basel II level 1 *Internal Fraud* category also has only two subcategories: (1) unauthorized activity and (2) theft and fraud. Examples of activities that are classified under unauthorized activity are intentionally not reporting transactions, unauthorized transaction type, and the intentional mismarking of positions. Examples of activities that are classified under the theft and fraud subcategory are fraud, theft, extortion, embezzlement, misappropriation of assets, forgery, tax evasion, and bribes.

The Basel II level 1 *Employment Practices and Workplace Safety* (*EPWS*) category has three subcategories: (1) employee relations, (2) safe environment, and (3) diversity and discrimination. Examples of activities that can lead to losses in the employee relations subcategory are compensation, benefit, termination, and organized labor. Examples of activities in the safe environment category are generally liabilities from accidents, employee health and safety rules, and workers' compensation. The last subcategory, diversity and discrimination, captures all activities related to discrimination issues.

The last Basel II level 1 category for OpRisk loss events is *Damage to Physical Assets* (*DPA*). The only subcategory is disasters and other events. This category and subcategory captures all loss events related to natural disasters and human losses from external sources such as vandalism and terrorism.

Collecting and Reporting Internal Loss Data

LO 41.2: Summarize the process of collecting and reporting internal operational loss data, including the selection of thresholds, the timeframe for recoveries, and reporting expected operational losses.

The foundation of an OpRisk framework is the internally created loss database. Any event that meets a firm's definition of an operational risk event should be recorded in the loss event database and classified based on guidelines in the operational risk event policy. Many firms adopt Basel II categories at the highest level and then customize lower level entries to match their firm's specific needs. A minimum of five years of historical data is required to satisfy Basel II regulatory guidelines. Collecting and analyzing operational risk events provides valuable insights into a firm's operational risk exposures. When loss data is not collected, it could be perceived by regulators that operational risk management issues are not a concern. Usually once a firm begins to collect loss data, the organization gains a new appreciation of its operational risks.

The collection of data is challenging because large amounts of data must be gathered over diverse geographical areas. The process of gathering data must ensure that it accurately reflects all loss information from all locations. The process should have checks and balances to ensure human errors are not present in gathering data and sending it to the central data collection point. Basel II regulations require a high degree of reliability in the loss data flow from all areas of the financial institution.

Financial institutions often create OpRisk filters to identify potential operational events used in the calculation of operational losses. These OpRisk filters are typically the most expensive cost in the process. However, filters provide important added assurance for regulators regarding the accuracy of the data collection process.

Basel II requirements allow financial institutions to select a **loss threshold** for loss data collection. This threshold amount will have significant implications for the risk profile of business units within the firm. OpRisk managers should not set the threshold for collecting loss data too low (e.g., $0) if there are business units that have a very large number of smaller losses, because it would require a very high amount of reporting. OpRisk managers should also not just think in terms of large OpRisk threshold amounts. The following example illustrates how setting a threshold too high will bias the total losses and therefore the risk profile for a financial institution.

Suppose the OpRisk manager for Bank XYZ sets the threshold at $50,000. Bank XYZ categorized all losses by the amount of the loss into loss brackets or buckets illustrated in Figure 4. The first row of Figure 4 states that there were two losses greater than $4,000,000 in the past year and the total amount of loss from these two events was $18,242,000. These two losses accounted for 25.3% of the total losses for the year. If a loss threshold was set at $50,000, then the last two rows or 28.3% of the total losses for the year would not be reported. Therefore, if the firm did not set a loss threshold for collecting data they would show that they actually had $72,136,148 of total losses instead of $51,724,314 (computed as $72,136,148 – $4,480,627 – $15,931,207).

Figure 4: Bank XYZ Total Annual Losses

Loss Bracket	*Events*	*Loss Amount*	*Percentage*
Over $4,000,000	2	$18,242,000	25.3%
$1,000,000 to $4,000,000	8	$17,524,400	24.3%
$500,000 to $1,000,000	9	$7,850,425	10.9%
$250,000 to $500,000	7	$1,825,763	2.5%
$100,000 to $250,000	10	$1,784,632	2.5%
$75,000 to $100,000	15	$1,948,971	2.7%
$50,000 to $75,000	18	$2,548,123	3.5%
$25,000 to $50,000	50	$4,480,627	6.2%
Less than $25,000	1230	$15,931,207	22.1%
Total		$72,136,148	100.0%

When quantifying capital requirements, Basel II does not allow **recoveries** of losses to be included in the calculation. Regulators require this rule because gross losses are always considered for capital calculations to provide a more realistic view of the potential of large losses that occur once every 1,000 years.

Another important issue to consider in the process of collecting loss data is the **timeframe for recoveries**. The financial crisis of 2007–2009 illustrated that the complexity of some loss events can lead to very long time horizons from the start of the loss event to the final closure. Complex litigation cases from this financial crisis took five to six years for resolutions. Sometimes loss events will take lawyers and OpRisk managers several years to estimate the loss amount.

While firms could create reserves for these losses, they seldom do to avoid giving the impression that they may owe a certain amount prior to reaching a judgment. The fact that many firms do not have legal expertise within the firm to handle these complex cases adds to the cost, because outsourcing of lawyers is often required. It is important for firms to have a policy in place for the processing of large long timeframe losses.

To help firms know what to report, the International Accounting Standards Board (IASB) prepared IAS37, which establishes guidelines on **loss provisions** or the reporting of expected operational losses after the financial crisis in 2007–2009. Three important requirements for the reporting of expected operational losses are as follows:

1. Loss provisions are not recognized for future operating losses.

2. Loss provisions are recognized for onerous contracts where the costs of fulfilling obligations exceed expected economic benefits.

3. Loss provisions are only recognized for restructuring costs when a firm has a detailed restructuring plan in place.

The IAS37 report states that loss provisions of restructuring costs should not include provisions related to relocation of staff, marketing, equipment investments, or distribution investments. Loss provisions must be recognized on the balance sheet when the firm has a current obligation regarding a past loss event. Balance sheet reporting of loss events is required when the firm is likely to be obligated for a loss and it is possible to establish a reliable estimate of the amount of loss. Gains from the disposal of assets or expected reimbursements linked to the loss should not be used to reduce the total expected loss amount. Reimbursements can only be recognized as a separate asset.

Identifying, Controlling, and Assessing Operational Risk

LO 41.3: Explain the use of a Risk Control Self-Assessment (RCSA) and key risk indicators (KRIs) in identifying, controlling, and assessing operational risk exposures.

The control environment plays an important role in mitigating operational losses. The OpRisk manager should map each business unit's processes, risks, and control mechanisms associated with the processes. For example, Figure 5 illustrates the equity settlement process for an equity trading firm. All major processes for the business unit are identified as the first step in managing risks.

Figure 5: Equity Settlement Process

A **risk control self-assessment** (RCSA) requires the documentation of risks and provides a rating system and control identification process that is used as a foundation in the OpRisk framework. Once the RCSA is created, it is commonly performed every 12–18 months to assess the business unit's operational risks. It is common for financial institutions to seek

expert opinions to help provide qualitative measures for the effectiveness of the RCSA framework. The experts perform an evaluation and color rate the performance in each process as Red, Amber, or Green (RAG) to indicate the level of risk based on historical process data.

The following four steps are commonly used in designing an RCSA program:

1. *Identify and assess risks* associated with each business unit's activities. The manager first identifies key functions in the firm and performs risk scenarios to assess potential losses, the exposure or potential loss amount, and the correlation risk to other important aspects of the firm such as financial, reputation, or performance.

2. *Controls* are then added to the RCSA program to mitigate risks identified for the firm. The manager also assesses any residual risk which often remains even after controls are in place.

3. *Risk metrics,* such as key risk indicators or internal loss events, are used to measure the success of OpRisk initiatives and are linked to the RCSA program for review. These risk metrics would also include all available external data and risk benchmarks for operational risks.

4. *Control tests* are performed to assess how effective the controls in place mitigate potential operational risks.

A major challenge for OpRisk managers is the ability to properly interpret output data of the aggregated RCSA framework. Outputs could give managers a false sense of security if risks are controlled within tolerances that are set too high. Alternatively, risk managers may weight some risks more heavily and take corrective actions that focus too intensively on specific "key" measures while spending too little focus on other important variables.

Key risk indicators (KRIs) are identified and used to quantify the quality of the control environment with respect to specific business unit processes. KRIs are used as indicators for the OpRisk framework in the same way that other quantitative measures are used in market and credit risk models. The collection of reliable data used as KRIs is an important aspect of the self-assessment process. The data collection process may be automated to improve the accuracy of the data, but there will be costs associated with implementation. Even though KRIs may be costly to measure, they provide the best means for measuring and controlling OpRisk for the firm.

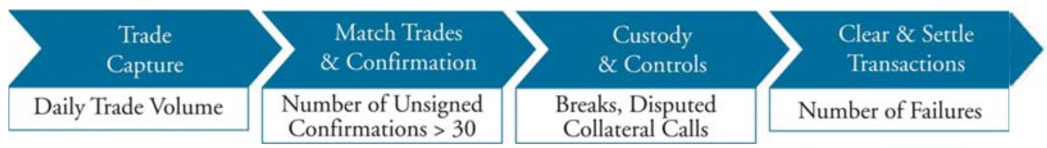
Regulators prefer the use of accurate quantitative KRIs in a control environment over more qualitative measures that only indicate whether the firm is getting better or worse based on historical losses. The more qualitative measures used in the example of the equity trading process in Figure 5 can be expanded to incorporate quantitative KRIs. Figure 6 includes examples of KRIs for the equity settlement process to help the firm self-assess the quality of the risk control environment.

The first step in creating an OpRisk model is identifying key factors that may be driving the success or failure of a business process. For example, the daily trade volume may be an important measure used to quantify how well the firm is executing the trade capture process. During the exercise of identifying KRIs, assumptions are made to determine proxies or inputs that drive the process. For example, execution errors are assumed to be greater

on high volume days. Other examples of KRIs that are used to predict execution errors are the number of securities that were not delivered, trading desk head count, and system downtime.

An important KRI for the process of matching trades and confirmation is the number of unsigned confirmations. KRIs are used as warning lights or red flags that highlight possible concerns for the firm. For example, when the number of unsigned confirmations older than 30 days as a percentage of total confirmations exceeds target percentages it indicates a problem area in the confirmation process. Similarly, the number of disputed collateral calls may be a good KRI for the custody and control step. Finally, the number of transactions that failed to clear or settle may be a good KRI for the settlement process.

Figure 6: Key Risk Indicators for an Equity Trading Firm



Collecting data at the lowest level or the cost center level allows information to be aggregated for all locations. This is very advantageous for the RCSA program because the OpRisk manager is then able to drill down or disaggregate the total data for the firm to help pinpoint where potential concerns may be originating.

Some additional examples of common internal control factors that are used to explain specific business environments are summarized in Figure 7.

Figure 7: Examples of Business Environment and Internal Control Factors (BEICFs)

Business Environment	*Factor Description*
Systems	Minutes system is down or slow
Information Security	Number of malware or hacking attacks
People	Headcount of employees, experience
Execution/Processing	Number of transactions or transaction breaks

External data such as stock market indices and market interest rate levels are also used in RCSA frameworks. For example, increased volatility in the equity market can lead to higher volume and higher operational losses for the firm. The insurance industry often relies on external databases to gather information on accidents or losses for areas or geographical regions they are less familiar with. Banks may also use external databases to gather information regarding losses for risks they have not been exposed to and therefore lack any relevant internal data.

Three common methods of gathering external data are: internal development, consortia, and vendors. Under the internal development method, the firm gathers and collates information from media such as news or magazines. This may be the least expensive method, but it may not be as accurate and has the potential to overlook large amounts of relevant data. The most popular consortium for banks is the **Operational Riskdata eXchange Association** (ORX), which contains large banks in the financial industry. While

this consortium has a relatively low loss reporting threshold, there are often no details on the losses and therefore this data can only be used for measurement. There are a number of vendors who provide detailed analysis on losses that can be used for scenario analysis. However, the loss threshold for vendor data is often much higher and the information may not always be accurate.

Scenario Analysis

LO 41.4: Describe and assess the use of scenario analysis in managing operational risk, and identify biases and challenges that can arise when using scenario analysis.

Scenario analysis is defined as the process of evaluating a portfolio, project, or asset by changing a number of economic, market, industry, or company specific factors. Scenario analysis models are especially useful tools for estimating losses when loss experiences related to emerging risks are not available to the financial institution. Inputs to scenario analysis models are collected from external data, expert opinions, internal loss trends, or key risk indicators (KRIs). Expert opinions are typically drawn from structured workshops for large financial institutions. However, surveys and individual meetings can also be used to gather expert advice. Studies suggest that most financial firms analyze between 50 and 100 scenarios on an annual basis.

One of the challenges in scenario analysis is taking expert advice and quantifying this advice to reflect possible internal losses for the firm. The following example illustrates how a firm may create a frequency distribution of loss events that can be used in scenario analysis.

Figure 8 illustrates data constructed for a financial institution based on expert inputs. Information is gathered on loss frequencies for pre-determined loss brackets. Thus, a frequency distribution is created to model the probability of losses based on the amount of loss on an annual basis. This frequency distribution is then used in the OpRisk framework for the firm.

Figure 8: Scenario Analysis Model for Loss Frequencies

Loss Bracket	*Number of Losses*	*Frequency*
Over $5,000,000	3	1.8%
$1,000,000 to $5,000,000	9	5.4%
$500,000 to $1,000,000	18	10.7%
$250,000 to $500,000	25	14.9%
$100,000 to $250,000	41	24.4%
$50,000 to $100,000	72	42.9%
Total	168	100.0%

Biases and Challenges of Scenario Analysis

One of the biggest challenges of scenario analysis is the fact that expert opinions are always subject to numerous possible biases. There is often disparity of opinions and knowledge regarding the amount and frequency of losses. Expert biases are difficult to avoid when conducting scenario analysis. Examples of possible biases are related to presentation, context, availability, anchoring, confidence, huddle, gaming, and inexpert opinion.

Presentation bias occurs when the order that information is presented impacts the expert's opinion or advice. Another similar type of bias is **context bias**. Context bias occurs when questions are framed in a way that influences the responses of those being questioned. In the case of scenario analysis, the context or framing of questions may influence the response of the experts.

Another set of biases are related to the lack of available information regarding loss data for a particular expert or for all experts. **Availability bias** is related to the expert's experience in dealing with a specific event or loss risk. For example, some experts may have a long career in a particular field and never actually experience a loss over $1 billion. The availability bias can result in over or under estimating the frequency and amount of loss events. A similar bias is referred to as anchoring bias. **Anchoring bias** can occur if an expert limits the range of a loss estimate based on personal experiences or knowledge of prior loss events. The availability an expert has to information can also result in a **confidence bias**. The expert may over or under estimate the amount of risk for a particular loss event if there is limited information or knowledge available for the risk or the probability of occurrence.

Expert opinions are often obtained in structured workshops that have a group setting. This group setting environment can lead to a number of biases. **Huddle bias** (also known as **anxiety bias**) refers to a situation described by behavioral scientists where individuals in a group setting tend to avoid conflicts and not express information that is unique because it results from different viewpoints or opinions. An example of a huddle bias would be a situation where junior experts do not voice their opinions in a structured workshop because they do not want to disagree in public with senior experts. Another concern for group environments is the possibility of **gaming.** Some experts may have ulterior motives for not participating or providing useful information in workshops. Another problem with workshop settings is the fact that top experts in the field may not be willing to join the workshop and prefer to work independently. The lack of top experts then attracts less experienced or junior experts who may have an **inexpert opinion**. These inexpert opinions can then lead to inaccurate estimates and poor scenario analysis models.

One technique that can help in scenario analysis is the **Delphi technique**. This technique originated from the U.S. Air Force in the 1950s and was designed to obtain the most reliable consensus of opinions from a group of experts. This technique is useful for many applications for analyzing cases where there is limited historical data available. More specifically, the Delphi technique is often applied in situations that exhibit some of the following issues:

- Precise mathematical models are not available but subjective opinions can be gathered from experts.
- Experts have a diverse background of experience and expertise, but little experience in communicating within expert groups.

- Group meetings are too costly due to time and travel expenses.
- A large number of opinions is required and a single face-to-face meeting is not feasible.

Under the Delphi technique, information is gathered from a large number of participants across various business units, areas of expertise, or geographical regions. The information is then presented in a workshop with representatives from each area. Recommendations are determined by this workshop group and quantified based on a pre-determined confidence level. A basic Delphi technique commonly goes through the following four steps:

1. Discussion and feedback is gathered from a large number of participants who may have diverse exposure and experience with particular risks.

2. Information gathered in step 1 is summarized and presented to a workshop group with representatives from various locations or business units surveyed.

3. Differences in feedback are evaluated from step 2.

4. Final evaluation and recommendations are made based on analysis of data and feedback from participants and/or respondents.

Operational Risk Profiles

LO 41.5: Compare the typical operational risk profiles of firms in different financial sectors.

Various business units within a financial institution are identified separately in an OpRisk profile. This allows the OpRisk manager to gather data for specific risks of each business unit. For example, an asset management unit typically has greater legal liability problems whereas an investment bank unit has more losses associated with transaction processing operational errors.

Basel II defines level 1 business units into the following categories: Trading and Sales, Corporate Finance, Retail Banking, Commercial Banking, Payment and Settlement, Agency Services, Asset Management, and Retail Brokerage. Large financial institutions typically define business units within their firm based on these Basel II definitions.

Figures 9 and 10 contrast the OpRisk profiles for five of these financial business units with respect to frequency and severity, respectively. The first columns of Figure 9 and Figure 10 summarize the type of event risk for each business unit. The frequency percentages based on the number of loss events are presented for each business unit in Figure 9. The severity percentages based on total dollar amount losses are presented for each business unit in Figure 10.

Figure 9: OpRisk Profiles Showing Frequency (%)

Event Type	*Trading & Sales*	*Corporate Finance*	*Retail Banking*	*Asset Management*	*Retail Brokerage*
Internal Fraud	1.0%	1.6%	5.4%	1.5%	5.8%
External Fraud	1.0%	5.4%	**40.3%**	2.7%	2.3%
Employment Practices	3.1%	10.1%	17.6%	4.3%	4.4%
Clients, Products, & Business Practices	**12.7%**	**47.1%**	**13.1%**	**13.7%**	**66.9%**
Physical Asset Damage	0.4%	1.1%	1.4%	0.3%	0.1%
System Failures & Business Disruptions	5.0%	2.2%	1.6%	3.3%	0.5%
Execution, Delivery, & Process Mgt	**76.7%**	**32.5%**	**20.6%**	**74.2%**	**20.0%**

Source: 2008 Loss Data collection exercise for Operational Risk BCBS (2009)

Figure 10: OpRisk Profile Showing Severity (%)

Event Type	*Trading & Sales*	*Corporate Finance*	*Retail Banking*	*Asset Management*	*Retail Brokerage*
Internal Fraud	11.0%	0.2%	6.3%	11.1%	18.1%
External Fraud	0.3%	0.1%	**19.4%**	0.9%	1.4%
Employment Practices	2.3%	0.6%	9.8%	2.5%	6.3%
Clients, Products, & Business Practices	**29.0%**	**93.7%**	**40.4%**	**30.8%**	**59.5%**
Physical Asset Damage	0.2%	0.0%	1.1%	0.2%	0.1%
System Failures & Business Disruptions	1.8%	0.0%	1.5%	1.5%	0.2%
Execution, Delivery, & Process Mgt	**55.3%**	**5.4%**	**21.4%**	**52.8%**	**14.4%**

Source: 2008 Loss Data collection exercise for Operational Risk BCBS (2009)

The two categories with the largest percentage of losses are emphasized in bold across different business units. The *Clients, Products, and Business Practices (CPBP)* unit and the *Execution, Delivery, and Process Management (EDPM)* unit have the largest losses across business units in terms of both frequency and severity of losses.

The number of losses related to the EDPM unit represented the highest frequency percentage and severity percentage for the *Trading and Sales* business unit in a 2008 survey of financial institutions. This is expected based on the number of trades executed daily by this business unit. Within this business unit, traders are required to execute trades for their firm or clients and then later settle the transactions. The complexity and wide range of products processed increases the possibility that errors may occur in the process. There is also a high frequency percentage and severity percentage related to the CPBP unit. Losses within this category arise from client or counterparty disputes, regulatory fines, and improper advisory activities.

The *Corporate Finance* business unit primarily provides consulting regarding initial public offerings, mergers and acquisitions, and other strategic planning. Figure 10 suggests that

over 93% of losses fall under the CPBP category. The majority of losses are from litigation from clients arguing IPOs were mispriced or some other improper advice.

The *Retail Banking* unit has the highest frequency of losses associated with external frauds at 40%. However, external fraud accounts for only about 20% of the total severity percentage. The largest severity percentage for the retail banking sector is the *Clients, Products, and Business Practices* category with *Execution, Delivery, and Process Management* as the next highest category.

Prior to the financial crisis of 2007–2009, *Asset Management* firms had steady increases in assets under management (AUM) as profits were realized across most financial markets in the bull market. Thus, most asset managers did not focus on operational costs. Conversely, after the crisis all costs became extremely important as AUM were reduced by as much as 40%. The lack of proper controls increased the losses beyond market related losses.

In addition to the financial crisis, one litigation case reached an unprecedented level and brought an added demand for increased controls. Bernie Madoff's Ponzi scheme caused many individuals to lose all of their investments and pension savings. These events have led to dramatic increases in OpRisk controls for the asset management industry. The asset management industry reduced operational costs by consolidating administration and distribution departments for large geographical regions. In addition, more focus is now concentrated toward reducing operational costs and risk management. Productivity has also seen changes as illustrated by select financial firms significantly reducing the number of products offered to focus on fewer products on a global scale.

OpRisk, market risk, and credit risk are all concerns for asset management firms. However, economic losses are largely due to OpRisk losses, because credit and market risks do not have an immediate impact on manager fee income. The OpRisk profile for asset management firms reveals the largest frequency and severity percentage in the *Execution, Delivery, and Process Management* area.

The OpRisk profile for firms in the *Retail Brokerage* industry can vary to some extent due to the wide range of business strategies ranging from online to brick-and-mortar broker-dealers. Changes in technologies have significantly increased the speed of trading and clients of broker-dealers now have direct market access through trading tools. Clients such as hedge funds, mutual funds, insurance companies, or wealthy individuals are able to directly access markets using the broker-dealer's market participant identifier (MPID). This greatly increases the operational risk for broker-dealers who are responsible for all trades made with their MPID. If trades are not filtered by the broker-dealer, then the risks are even greater.

For example, due to the high speed of trades driven by algorithms and large blocks of trades, a two-minute delay in detecting a mistake could lead to losses approaching three-quarters of a billion dollars. Thus, it is important to integrate pre-trade controls into the system to mitigate the risk of mistakes or entry errors. The OpRisk profile of the retail brokerage industry has the largest frequency and severity percentage in the *Clients, Products, and Business Practices* area.

There was no loss frequency or severity data provided for the *Insurance* sector. Perhaps this is due to the fact that firms in the insurance industry are still in the early stages of developing accurate OpRisk frameworks and there is no data available. The insurance sector

is divided into three major insurance types: life, health, and property and casualty. The insurance industry collects premiums for insuring individual losses and the insurer pays for losses incurred by policyholders, thus reducing the possibility of a large loss for any one individual.

In order to properly price the premiums, the insurer must have accurate actuarial calculations. In fact, OpRisk capital requirement models determined by regulators are designed after actuarial calculation models in the property and casualty insurance industry. Some major OpRisks for insurers include misselling products to clients, fraudulent sales techniques, customer frauds, discrimination litigation, and incomplete policy litigation following the 9/11 attacks.

Organizational Structures for Risk Governance

LO 41.6: Explain the role of operational risk governance and explain how a firm's organizational structure can impact risk governance.

A key factor in creating a successful OpRisk framework is the organizational design of the risk management framework. Developing an understanding of reporting lines is just as important as developing good measurement tools and key risk indicators. All stakeholders for the organization should be informed of the OpRisk framework to help ensure that data is collected accurately and reflects the systems in place. The way in which risk is managed in an organization and the internal governance is an important aspect of OpRisk management.

There are four main organizational designs for integrating the OpRisk framework within the organization. Most large firms start at design 1 and progress to design 4 over time. The four organizational designs are illustrated in Figure 11 and summarized below.

Design 1: Central Risk Function Coordinator

In the first risk organizational design, the risk manager is viewed more as a coordinator or facilitator of risk management. This risk management design typically involves only a small Central Risk group who is responsible for OpRisk management. The risk manager gathers all risk data and then reports directly to the Chief Executive Officer (CEO) or Board of Directors. Regulators believe there exists a conflict of interest for reporting risk data directly to management or stakeholders that are primarily concerned with maximizing profits. Thus, this design can only be successful if business units are responsive to the Central Risk function without being influenced by upper management who controls their compensation and evaluates their performance.

Design 2: Dotted Line or Matrix Reporting

Creating a link or dotted line from the business risk managers to the Central Risk function of the organization is the next natural progression in risk organizational design. The dotted line implies that business unit managers are still directly under the influence of the CEO who controls their compensation and evaluates their performance. Thus, this type of framework is only successful if there is a strong risk culture for each business unit that

encourages collaboration with the Central Risk function. Furthermore, this dotted line structure is preferred when there is a culture of distrust of the Central Risk function based on some historical events.

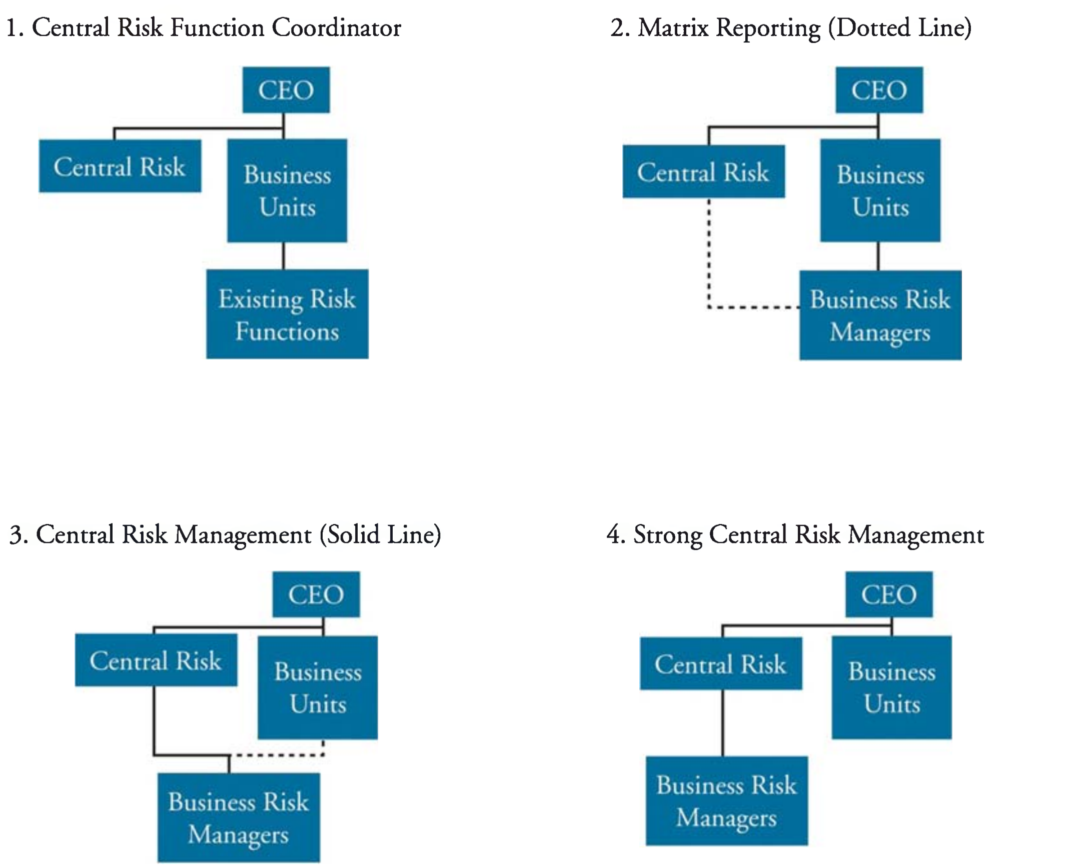
Design 3: Solid Line Reporting

For larger firms that have centralized management, the solid line reporting is more popular. The solid line indicates that each business unit has a risk manager that reports directly to the Central Risk function. This design enables the Central Risk function to more effectively prioritize risk management objectives and goals for the entire firm. The solid line reporting also creates a more homogeneous risk culture for the entire organization.

Design 4: Strong Central Risk Management

Many large firms have evolved into a strong central risk management design either voluntarily or from regulatory pressure. Under this design, there is a Corporate Chief Risk Officer who is responsible for OpRisk management throughout the entire firm. The Central Risk Manager monitors OpRisk in all business units and reports directly to the CEO or Board of Directors. Regulators prefer this structure as it centralizes risk data which makes regulatory supervision easier for one direct line of risk management as opposed to numerous risk managers dispersed throughout various business units of the firm.

Figure 11: Risk Department Organizational Designs



Key Concepts

LO 41.1

Basel II classifies loss events into seven categories. Loss events in the Execution, Delivery, and Process Management category have a small dollar amount but a very large frequency of occurrence. Losses are more infrequent but very large in the Clients, Products, and Business Practices category.

LO 41.2

Thresholds for collecting loss data should not be set too low if there are business units that have a very large number of smaller losses. Another important issue to consider in the process of collecting loss data is the timeframe for recoveries. Time horizons for complex loss events can stretch out for as much as five years or longer.

The International Accounting Standards Board (IASB) prepared IAS37, which states that loss provisions: (1) are not recognized for future operating losses, (2) are recognized for onerous contracts where the costs of fulfilling obligations exceed expected economic benefits, and (3) are only recognized for restructuring costs when a firm has a detailed restructuring plan in place.

LO 41.3

Risk control self-assessment (RCSA) requires the assessment of risks that provides a rating system and control identification process for the OpRisk framework. Key risk indicators (KRIs) are used to quantify the quality of the control environment with respect to specific business unit processes.

LO 41.4

Expert opinions are drawn from structured workshops and used as inputs in scenario analysis models. A challenge for scenario analysis is that these expert opinions may contain the following biases: presentation, context, availability, anchoring, huddle, gaming, confidence, and inexpert opinion.

LO 41.5

In general, the Clients, Products, and Business Practices unit and the Execution, Delivery, and Process Management unit have the largest losses based on OpRisk profiles across financial sectors in terms of severity and frequency of losses.

LO 41.6

There are four main organizational designs for integrating an OpRisk framework. Most large firms evolve from design 1 to design 4 over time. The primary difference in the designs is how risk is reported and the link between separate business unit risk managers and the Central Risk function.

Concept Checkers

1. Suppose a broker-dealer has a loss that occurs from a failure in properly processing and settling a transaction. According to Basel II operational risk categories, this type of event loss would be categorized as:
   A. Business Disruption and System Failures.
   B. Clients, Products, and Business Practices.
   C. Execution, Delivery, and Process Management.
   D. Employment Practices and Workplace Safety.

2. There are typically four steps used in designing the risk control self-assessment (RCSA) program for a large firm. Which of the following statements is least likely to be a step in the design of that program?
   A. Identify and assess risks associated with each business unit's activities.
   B. Controls are added to the RCSA program to mitigate risks identified for the firm.
   C. Risk metrics and all other OpRisk initiatives are linked to the RCSA program.
   D. Reports to regulators are prepared that summarize the degree of OpRisk.

3. Scenario analysis is often used by financial institutions in determining the amount and frequency of losses. Because historical data is often limited for all possible losses, the opinions of experts are often obtained from workshops. These expert opinions are often subject to biases. Which of the following biases refers to the problem that can arise in this group setting where an expert may not be willing to share a conflicting opinion?
   A. Huddle bias.
   B. Context bias.
   C. Availability bias.
   D. Anchoring bias.

4. Based on OpRisk profiles across financial sectors, which of the following loss event type categories have the highest frequency and severity of losses?
   A. Business Disruption and System Failures.
   B. Clients, Products, and Business Practices.
   C. External Fraud.
   D. Internal Fraud.

5. Which of the following risk organizational design frameworks is preferred by regulators?
   A. Central risk function coordinator.
   B. Matrix reporting using dotted lines.
   C. Solid line reporting to central risk management.
   D. Strong central risk management.

Concept Checker Answers

1. **C** Basel II classifies losses from failed transaction processing or process management from relations with trade counterparties and vendors under the Execution, Delivery, and Process Management category.

2. **D** The last step in the design of a risk control self-assessment (RCSA) program involves control tests to assess how well the controls in place mitigate potential risks.

3. **A** Huddle bias suggests that groups of individuals tend to avoid conflicts that can result from different viewpoints or opinions. Availability bias is related to the expert's experience in dealing with a specific event or loss risk. Anchoring bias occurs when an expert limits the range of a loss estimate based on personal knowledge. Context bias occurs when questions are framed in a way that influences the responses of those being questioned.

4. **B** From the choices listed the Clients, Products, and Business Practices unit has the highest frequency percentages and severity of loss percentages across business units. The Execution, Delivery, and Process Management unit also has large losses across business units in terms of frequency and severity of losses, however, this category was not listed as a possible choice.

5. **D** Regulators prefer the strong central risk management design because they can streamline their supervision over one direct line of risk management as opposed to numerous risk managers throughout the firm.

The following is a review of the Operational and Integrated Risk Management principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

External Loss Data

Topic 42

Exam Focus

This topic examines the motivations for using external operational loss data and compares characteristics of loss data from different sources. For the exam, understand why firms are motivated to use external data in their internal operational risk framework development and the types of data that are available. Also, understand the differences in construction methodologies between the ORX and FIRST databases and be able to cite examples of how these differences manifest themselves in the data. Finally, be able to describe the Société Générale operational loss event.

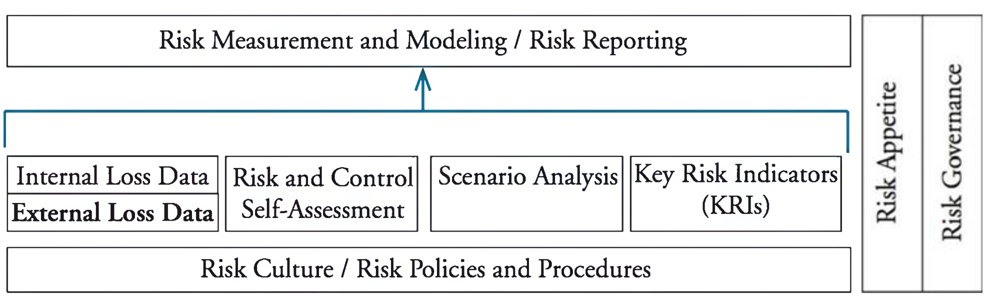
Collecting External Loss Data

LO 42.1: Explain the motivations for using external operational loss data and common sources of external data.

One reason operational risk departments look at events outside the firm is to gain valuable insights and inputs into operational risk capital calculations. Furthermore, external data is a required element in the advanced measurement approach (AMA) capital calculation under Basel II.

External events can be useful in many areas of the firm's operational risk framework, as these events provide information for risk self-assessment activities. They are key inputs in scenario analysis and can help in developing key risk indicators for monitoring the business environment.

Figure 1: External Loss Data in the Operational Risk Framework



Senior management should take an interest in external events because news headlines can provide useful information on operational risk. Examining events among industry peers and competitors helps management understand the importance of effective operational risk management and mitigation procedures. This is why external data is the key to developing a strong culture of operational risk awareness.

An example of a huge risk event that impacted industry discipline is the €4.9 billion trading scandal at Société Générale in 2006. This internal loss for Société Générale demonstrated to the financial services industry how operational risk can lead to large losses. In spite of the lessons learned from this experience, the financial industry saw another huge trading loss event at UBS in 2011, which led firms to reassess how they respond to external events and to ensure any lessons learned do not go unheeded.

Sources of External Loss Data

There are many sources of operational risk event data in the form of news articles, journals, and email services. Operational risk system vendors offer access to their database of events, and there are consortiums of operational risk losses as well. External events are a valuable source of information on individual events and also serve as a benchmarking tool for comparing internal loss patterns to external loss patterns. This process provides insight into whether firm losses are reflective of the industry.

Subscription Databases

Subscription databases include descriptions and analyses of operational risk events derived from legal and regulatory sources and news articles. This information allows firms to map events to the appropriate business lines, risk categories, and causes. The primary goal of external databases is to collect information on tail losses and examples of large risk events. An excerpt showing the total operational risk loss percentages to date by risk category in the IBM Algo FIRST database is shown in Figure 2.

Figure 2: Operational Risk Losses Recorded in IBM Algo FIRST (Q4 2012)

Event Type	*% of Losses*	*% of Events*
Business Disruption and System Failures	0.41%	1.54%
Clients, Products, and Business Practices	48.25%	46.11%
Damage to Physical Assets	19.22%	3.18%
Employment Practices and Workplace Safety	0.88%	5.97%
Execution, Delivery, and Process Management	6.68%	7.28%
External Fraud	3.94%	9.71%
Internal Fraud	20.63%	26.20%
Total	**100%**	**100%**

Through these statistics, we can see some patterns in operational risk events. For example, 46% of all records fall into the category of Clients, Products, and Business Practices, accounting for 48% of dollar value losses. Internal Fraud is another large area of risk events, with 26% of records and 21% of losses. Damage to Physical Assets is the next most expensive category with 19% of losses but only 3% of events.

Figure 2 shows us that within an internal database such IBM Algo FIRST (FIRST), operational risk losses from Internal Fraud, Damage to Physical Assets, and Client, Products, and Business Practices are more significant than those from other categories. However, keep in mind that the FIRST database includes business lines that are not part of the Basel-specified business lines. This results in relatively high Damage to Physical Assets losses, as insurance company losses are included in that category.

In Figure 3, we see subsets of losses from the FIRST database. (Note that any losses not attributed to one of the Basel business lines have been removed.)

Figure 3: FIRST Losses by Business Line (Q4 2012)

Business Line	*% of Losses*	*% of Events*
Agency Services	0.35%	2.22%
Asset Management	14.40%	16.37%
Commercial Banking	23.42%	17.70%
Corporate Finance	17.56%	9.00%
Payment and Settlement	2.72%	5.90%
Retail Banking	23.67%	20.79%
Retail Brokerage	1.30%	10.33%
Trading and Sales	16.58%	17.70%
Total	**100%**	**100%**

Figure 3 shows about 10% of events occur in the Retail Brokerage business line, but these retail brokerage events account for only 1% of losses because average losses in this business line are relatively small. Conversely, we see that Corporate Finance generated 9% of events but accounted for 18% of losses. Clearly, average losses in Corporate Finance tend to be more expensive.

We should keep in mind that this analysis is based on publicly available data for operational risk events, which is subject to reporting bias. The FIRST database is useful for financial services firms to compare their risk profiles to the industry by category and business line. FIRST provides insights into events that may not have occurred at a particular firm in the risk modeling process.

Consortium Data

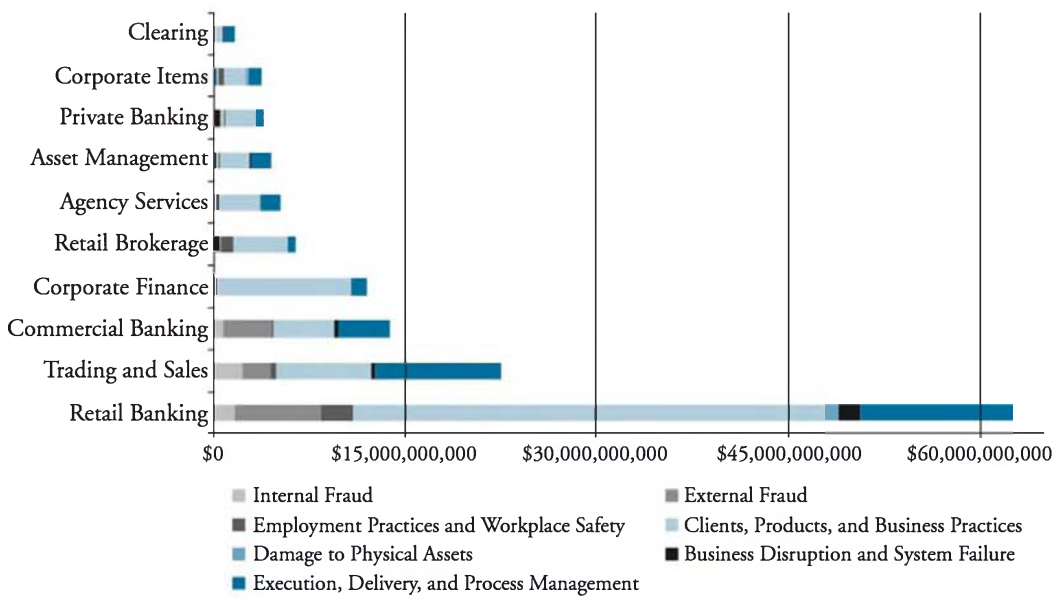
Besides the FIRST approach to collecting data, there are also consortium-based risk event services that provide a central data repository. **Operational Riskdata eXchange Association** (ORX) is a provider of this data, which is gathered from members to provide benchmarking. ORX applies quality assurance standards to keep all receipt and delivery of data anonymous and to provide consistency in definitions of events.

Unlike subscription services, ORX data does not suffer from the availability bias that skews the FIRST data (which relies on public sources of information). With ORX, all events are entered anonymously into the database; however, the data relates only to a small subset of firms that are members of the consortium. ORX also uses different business lines than FIRST. For example, it splits retail banking into two groups: Retail Banking and Private

Banking. It also renames Payment and Settlement to "Clearing." The ORX database has gathered nearly 30,000 events costing its members over €100 billion, which helps highlight the potential costs of operational risk.

ORX publishes reports that summarize the number and amount of losses for each business line and risk category. Regarding the reported contributions, the Retail Banking business area generates 58% of events; most of them in the External Fraud category. Trading and Sales and Commercial Banking follow with about 10% of total events each. Retail Banking has the biggest share of total costs at 46% of total losses. Execution, Delivery, and Process Management produce the largest number of events (36%), with 25% of total costs. Also, Clients, Products, and Business Practices accounts for about 17% of events but more than 50% of losses, which demonstrates that for members of ORX, these events tend to be large. Many firms use information from this category to conduct scenario analysis for potential "fat tail" events. Data representing dollar value losses of operational risk for each business line is shown in Figure 4.

Figure 4: Dollar Value Losses by Risk Category and Business Line



Subscription vs. Consortium Databases

LO 42.2: Explain ways in which data from different external sources may differ.

Differences in the collection methods between the ORX and the FIRST databases have an interesting impact on the relative distribution of the loss data.

Size and Frequency of Losses by Risk Category

When comparing the size of losses by risk category in the ORX and FIRST databases, we see that the FIRST database has a significantly higher percentage of losses for Internal Fraud than ORX does. In contrast, ORX has a significantly higher percent of Execution, Delivery,

and Process Management losses than does FIRST. This could be because not all Execution, Delivery, and Process Management losses are reported by the press, implying that the FIRST database is missing many events and has an unavoidable collection bias.

The primary difference between these two databases with respect to Execution, Delivery, and Process Management events is that ORX data is supplied directly from member banks, which does not include all banks, implying that ORX also suffers from collection bias. This is in contrast to the FIRST database that collects data on all firms, including a significant number of firms outside of Basel II compliance.

Regarding the frequency of losses by risk category, Execution, Delivery, and Process Management events are missing from FIRST data, presumably because they rarely get press coverage. ORX has a larger frequency of External Fraud than FIRST, which suggests that such events are often kept from the press. ORX data also shows a large amount of External Fraud due to the participation of retail banks in the consortium. This is because Retail Banking includes credit card services, which causes this category to be driven by numerous small instances of fraud in retail banking and credit cards. The threshold for reporting loss data to ORX is €20,000.

Size and Frequency of Losses by Business Line

When comparing the size of losses by business lines in the ORX and FIRST databases, ORX losses are heavily weighted toward Retail Banking. Also, Commercial Banking accounts for a smaller percentage of losses for ORX than for FIRST, which may be due to recent commercial banking events making it into the press and, therefore, into the FIRST database (but not the ORX database).

Regarding the frequency of losses by business line, ORX data is driven by Retail Banking events, whereas FIRST events are more evenly distributed among the various business lines. Also, the majority of events for ORX and FIRST occur in Retail Banking but by a slimmer margin for the FIRST database.

Challenges with Using External Data

LO 42.3: Describe the challenges that can arise through the use of external data.

Many firms' operational risk systems not only include ORX and FIRST data but are also supplemented with information from the firm's own research and relevant industry news and journals. However, as we noted previously about the various differences between ORX and FIRST, the databases must be viewed with caution, as there are several challenges with using external data.

For example, external data derived from the media is subject to reporting bias. This is because it is up to the press to decide which events to cover, and the preference is for illegal and dramatic acts. For instance, consider that a large internal trading fraud might get press coverage, while a systems outage might get none. We should also consider that a major gain is less likely to be reported by the media than a major loss. Another barrier to determining whether an event is relevant is that some external events may be ignored because they are

perceived as types of events that "could not happen here." Finally, the use of benchmark data may be a concern because there is a chance that comparisons may not be accurate due to different interpretations of the underlying database definitions.

One of the best ways to use external data is not to spot exact events to be avoided but rather to determine the types of errors and control failings that could cause similar losses. External data may have direct relevance despite differences in the details. For example, the Société Générale event led many firms to overhaul their fraud controls.

External data can serve a valuable role in operational risk management if its limitations are acknowledged. Databases can provide valuable lessons about risk management and highlight trends in the industry. While internal and external databases only tell us about what has already gone wrong, the data can be used to implement controls to mitigate the chances of similar events repeating, and they provide valuable inputs into the operational risk framework. Loss data is also useful for self-assessment, scenario analysis, and key risk indicators (KRIs) that indicate loss trends and weaknesses in controls.

Société Générale Operational Loss Event

LO 42.4: Describe the Société Générale operational loss event and explain the lessons learned from the event.

In January 2008, it was discovered that one of Société Générale's junior traders, Jérôme Kerviel, was involved in rogue trading activities, which ultimately resulted in losses of €4.9 billion. The multinational bank was fined €4 million, and Mr. Kerviel was sentenced to three years in prison. The incident damaged the reputation of Société Générale and required the bank to raise additional funds to meet capital needs.

Between July 2005 and January 2008, Kerviel established large, unauthorized positions in futures contracts and equity securities. To hide the size and riskiness of these unauthorized positions, he created fake transactions that offset the price movements of the actual positions. Kerviel created fake transactions with forward start dates and then used his knowledge of control personnel confirmation timing to cancel these trades right before any confirmations took place. Given the need to continuously replace fake trades with new ones, Kerviel created close to 1,000 fictitious trades before the fraud was finally discovered.

The operational risk world was galvanized by this event as it demonstrated the dangers of unmitigated operational risk. In 2008, many firms were developing operational risk frameworks and often focused on the delivery of new reporting, loss data tools, and adaptions to their scenario analysis programs. However, even though firms were developing internal risk systems, the amount of new regulatory requirements rapidly overcame their ability to keep up in practice. With the news of Mr. Kerviel's activities, many heads of operational risk found themselves asking the question "Could that happen here?"

IBM Algo FIRST provided an analysis based on press reviews. The highlights of alleged contributing factors to this operational loss event are summarized as follows:

1. Mr. Kerviel was involved in extensive unauthorized trading activities.

2. Mr. Kerviel was not sufficiently supervised.

3. Mr. Kerviel used his knowledge of middle and back office controls to ensure his fraud went undetected.

4. Mr. Kerviel achieved password access to systems allowing him to manipulate trade data.

A number of reasons were cited that explained how Kerviel's unauthorized trading activity went undetected, including the incorrect handling of trade cancellations, the lack of proper supervision, and the inability of the bank's trading system to consider gross positions.

Regarding trade cancellations, the bank's system was not equipped to review trading information that was entered and later canceled. In addition, the system was not set up to flag any unusual levels of trade cancellations. Regarding the lack of supervision, oversight of Kerviel's trading activity was weak, especially after his manager resigned in early 2007. Under the new manager, Kerviel's unauthorized trading activity increased significantly. Regarding the size of Kerviel's positions, the bank's system was only set up to evaluate net positions instead of both net and gross positions. Thus, the abnormally large size of his trading positions went undetected. Had the system properly monitored gross positions, it is likely that the large positions would have issued a warning sign given the level of riskiness associated with those notional amounts. Also, the large amount of trading commissions should have raised a red flag to management.

Additional reasons that contributed to the unauthorized positions going undetected included the inaction of Kerviel's trading assistant to report fraudulent activity, the violation of the bank's vacation policy, the weak reporting system for collateral and cash accounts, and the lack of investigation into unexpected reported trading gains.

Kerviel's trading assistant had immediate access to Kerviel's trading activities. Because the fictitious trades and the manipulation of the bank's trading system went unreported, it was believed that the trading assistant was acting in collusion with Kerviel. Regarding the bank's vacation policy, the rule that forced traders to take two weeks of vacation in a row was ignored. Had this policy been enforced, another trader would have been responsible for Kerviel's positions and likely would have uncovered the fraudulent activity of rolling fake transactions forward. Regarding collateral and cash reports, the fake transactions did not warrant any collateral or cash movements, so nothing balanced the collateral and cash needs of the actual trades that were being offset. If Société Générale's collateral and cash reports had been more robust, it would have detected unauthorized movements in the levels of these accounts for each individual trader. Regarding reported trading gains, Kerviel inflated trading gains above levels that could be reasonably accounted for given his actual authorized trades. This action should have prompted management to investigate the source of the reported trading gains.

Ultimately, the unauthorized trading positions were discovered by chance after one of Kerviel's fake trades was detected by control personnel during a routine monitoring of positions. Kerviel's inability to explain the fictitious transaction led to a rigorous investigation, revealing the depth of his fraudulent activities.

Lessons to be learned specific to this operational loss event include the following:

- Traders who perform a large amount of trade cancellations should be flagged and, as a result, have a sample of their cancellations reviewed by validating details with trading counterparties to ensure cancellations are associated with real trades.
- Tighter controls should be applied to situations that involve a new or temporary manager.
- Banks must check for abnormally high gross-to-net-position ratios. High ratios suggest a greater probability of unauthorized trading activities and/or basis risk measurement issues.
- Control personnel should not assume the independence of a trading assistant's actions. Trading assistants often work under extreme pressure and, thus, are susceptible to bullying tactics given that job performance depends on them following direction from traders.
- Mandatory vacation rules should be enforced.
- Requirements for collateral and cash reports must be monitored for individual traders.
- Profit and loss activity that is outside reasonable expectations must be investigated by control personnel and management. Reported losses or gains can be compared to previous periods, forecasted values, or peer performance.

Key Concepts

LO 42.1

Operational risk departments look at events outside the firm to gain valuable insights and inputs into operational risk capital calculations. External events can also be useful in many areas of a firm's operational risk framework, as they provide information useful for risk self-assessment activities. These events are key inputs in scenario analysis and can help in developing key risk indicators for monitoring the business environment. Additionally, external data is a required element in the advanced measurement approach (AMA) capital calculation.

Subscription databases include descriptions and analyses of operational risk events, which are derived from legal and regulatory sources and news articles. In addition to database systems, there are also consortium-based risk event services that provide a central data repository to member firms and can offer benchmarking services as well. ORX is a provider of this type of data.

LO 42.2

When comparing data in the FIRST and ORX databases, we see significant differences between them. The FIRST database has a significantly higher percentage of losses for Internal Fraud than does ORX. In contrast, ORX has a significantly higher percent of Execution, Delivery, and Process Management losses. This could be because not all Execution, Delivery, and Process Management events are reported by the press, implying the FIRST database is missing many events and has an unavoidable collection bias.

Another difference between the two databases with respect to Execution, Delivery, and Process Management events is that ORX data is supplied directly from member banks. However, not all banks are ORX members, implying that ORX likely also suffers from collection bias. This is in contrast to the FIRST database that collects data on all firms, including a significant number of firms outside of Basel II compliance.

LO 42.3

ORX and FIRST databases must be viewed with caution, as there are several challenges with using external data. For example, external data derived from the media is subject to reporting bias because the press is far more likely to cover illegal and dramatic events. The use of benchmark data is also a concern, as there is a chance that comparisons are not accurate because of different interpretations of the underlying database definitions.

One of the best ways to use external data is not to spot exact events to be avoided but rather to determine the types of errors and control failings necessary to avoid similar losses. External data can still have a valuable role in operational risk management if staff acknowledges any limitations. Databases can provide valuable lessons about risk management and highlight trends in the industry.

LO 42.4

Jérôme Kerviel, a junior trader at Société Générale, participated in unauthorized trading activity and concealed this activity with fictitious offsetting transactions. The fraud resulted in €4.9 billion in losses and severely damaged the reputation of Société Générale.

Concept Checkers

1. Which of the following reasons is least likely to be a motivation for firms to use external data?
   A. To provide inputs into operational risk calculations.
   B. To engage in risk self-assessment activities.
   C. To ignore any operational loss events outside of external loss databases.
   D. To use in the advanced measurement approach (AMA) capital calculation.

2. In the IBM Algo FIRST database, which event type accounts for the most risk events?
   A. Business Disruptions and Systems Failures.
   B. Execution, Delivery, and Process Management.
   C. Clients, Products, and Business Practices.
   D. Internal Fraud.

3. Which database is likely to suffer from selection bias for Execution, Delivery, and Process Management losses because not all events are reported in the press?
   I. IBM Algo FIRST
   II. Operational Riskdata eXchange Association (ORX)
   A. I only.
   B. II only.
   C. Both I and II.
   D. Neither I nor II.

4. Which of the following statements is least likely to be a limitation of using external databases? External databases:
   A. must be viewed with caution.
   B. suffer from collection biases.
   C. do not report all events.
   D. cannot be used in internal calculations.

5. Which of the following statements was not a contributing factor to Jérôme Kerviel's activities at Société Générale? Mr. Kerviel:
   A. engaged in extensive unauthorized activities.
   B. engaged in rogue trading despite being sufficiently supervised.
   C. had knowledge of controls to ensure his activities were not detected.
   D. gained password access to back office systems to manipulate data.

Concept Checker Answers

1. **C** Operational risk departments look at events outside the firm to gain valuable insights and inputs into operational risk capital calculations. Firms should understand that external loss databases only include a sample of potential operational loss events.

2. **C** Forty six percent of all records in the FIRST database fall into the category of Clients, Products, and Business Practices, more than any other category.

3. **A** Because not all Execution, Delivery, and Process Management events are reported by the press, it is likely that the FIRST database is missing many events and, thus, has an unavoidable collection bias.

4. **D** The use of external databases is critical to firms' operational risk management calculations, an example of which is observing fat tail events at other firms.

5. **B** Mr. Kerviel was insufficiently supervised according to IBM Algo FIRST.

The following is a review of the Operational and Integrated Risk Management principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

Capital Modeling

Topic 43

Exam Focus

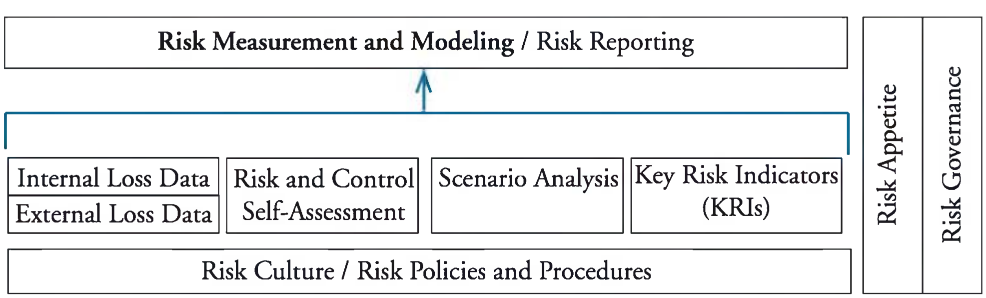
This topic discusses approaches for modeling operational risk capital requirements. Collecting data for loss frequency and loss severity distributions is an important component of allocating operational risk capital among various bank business lines. The loss distribution approach (LDA) models losses with respect to both frequency and severity with the goal of determining the appropriate level of capital. For the exam, be able to compare the approaches for calculating operational risk capital charges and be able to describe the LDA for modeling capital. Approaches for calculating operational risk capital requirements will be covered again in Topics 44 and 58.

Operational Risk Capital Requirements

LO 43.1: Compare the basic indicator approach, the standardized approach, and the alternative standardized approach for calculating the operational risk capital charge, and calculate the Basel operational risk charge using each approach.

Basel II proposed three approaches for determining the operational risk capital requirement (i.e., the amount of capital needed to protect against the possibility of operational risk losses). The **basic indicator approach** (BIA) and the **standardized approach** (TSA) determine capital requirements as a multiple of gross income at either the business line or institutional level. The **advanced measurement approach** (AMA) offers institutions the possibility to lower capital requirements in exchange for investing in risk assessment and management technologies. If a firm chooses to use the AMA, calculations will draw on the underlying elements illustrated in Figure 1.

Figure 1: Role of Capital Modeling in the Operational Risk Framework



Basel II encourages banks to develop more sophisticated operational risk management tools and expects international banks to use either the standardized approach or advanced measurement approach. In fact, many nations require large financial institutions to calculate operational risk with the AMA in order to be approved for Basel II.

Basic Indicator Approach

With the BIA, operational risk capital is based on 15% of the bank's annual gross income (GI) over a three-year period. Gross income in this case includes both net interest income and noninterest income. The capital requirement, K_{BIA}, under this approach is computed as follows:

$$K_{BIA} = \frac{\left(\sum_{i=1}^{n} GI_i \times \alpha\right)}{n}$$

where:
GI = annual (positive) gross income over the previous three years
n = number of years in which gross income was positive
α = 15% (set by Basel Committee)

Firms using this approach are still encouraged to adopt the risk management elements outlined in the Basel Committee on Banking Supervision, Risk Management Group, "Sound Practices for the Management and Supervision of Operational Risk." When a firm uses the BIA, it does not need loss data, risk and control self-assessment, scenario analysis, and business environment internal control factors (BEICF) for capital calculations. However, these data elements are needed as part of an operational risk framework to ensure risks are adequately identified, assessed, monitored, and mitigated.

Example 1: Calculating BIA capital charge

Assume Omega Bank has the following revenue results from the past three years:

	Year 1	*Year 2*	*Year 3*
Annual Gross Revenue (in $100 millions)	25	30	35

Calculate the operational risk capital requirement under the BIA.

Answer:

$$K_{BIA} = \frac{[(25+30+35)\times 0.15]}{3} = 4.5$$

Thus, Omega Bank must hold $450 million in operational risk capital under Basel II using the basic indicator approach.

Example 2: Calculating BIA capital charge

Assume Theta Bank has the following revenue results from the past three years:

	Year 1	*Year 2*	*Year 3*
Annual Gross Revenue (in $100 millions)	10	–5	15

Calculate the operational risk capital requirement under the BIA.

Answer:

Because Year 2 is negative, it will not count toward the sum of gross income over the past three years. This will also reduce the value of *n* to two.

$$K_{BIA} = \frac{[(10+15)\times 0.15]}{2} = 1.875$$

Thus, Theta Bank must hold $187.5 million in operational risk capital under Basel II using the basic indicator approach.

The BIA for risk capital is simple to adopt, but it is an unreliable indication of the true capital needs of a firm because it uses only revenue as a driver. For example, if two firms had the same annual revenue over the last three years, but widely different risk controls, their capital requirements would be the same. Note also that operational risk capital requirements can be greatly affected by a single year's extraordinary revenue when risk at the firm has not materially changed.

The Standardized Approach

For the standardized approach (TSA), the bank uses eight business lines with different **beta factors** to calculate the capital charge. With this approach, the beta factor of each business line is multiplied by the annual gross income amount over a three-year period. The results are then summed to arrive at the total operational risk capital charge under the standardized approach. The beta factors used in this approach are shown as follows:

- Investment banking (corporate finance): 18%.
- Investment banking (trading and sales): 18%.
- Retail banking: 12%.
- Commercial banking: 15%.
- Settlement and payment services: 18%.
- Agency and custody services: 15%.
- Asset management: 12%.
- Retail brokerage: 12%.

The standardized approach attempts to capture operational risk factors not covered by the BIA by assuming that different business activities carry different levels of operational risk.

Any negative capital charges from business lines can be offset up to a maximum of zero capital. The capital requirement, K_{TSA}, under this approach is computed as follows:

$$K_{TSA} = \frac{\left\{ \sum_{3 \text{ Years}} \max\left[\sum (GI_{1-8} \times \beta_{1-8}), 0\right] \right\}}{3}$$

where:
$GI_{1\text{-}8}$ = annual gross income in a given year for each of the eight business lines
$\beta_{1\text{-}8}$ = beta factors (fixed percentages for each business line)

In the following examples, Gamma Bank has only three lines of business and uses the standardized approach for its operational risk capital calculation.

Example 1: Calculating TSA capital charge

Assume Gamma Bank has the following revenue (in $100 millions) for the past three years for its three lines of business: trading and sales, commercial banking, and asset management.

Business Line	*Year 1*	*Year 2*	*Year 3*
Trading and Sales	10	15	20
Commercial Banking	5	10	15
Asset Management	10	10	10

Calculate the operational risk capital requirement under TSA.

Answer:

To calculate TSA capital charge, we first incorporate the relevant beta factors as follows:

Business Line	*Year 1*	*Year 2*	*Year 3*
Trading and Sales	10 × 18% = 1.8	15 × 18% = 2.7	20 × 18% = 3.6
Commercial Banking	5 × 15% = 0.75	10 × 15% = 1.5	15 × 15% = 2.25
Asset Management	10 × 12% = 1.2	10 × 12% = 1.2	10 × 12% = 1.2
Total	3.75	5.4	7.05

Next, enter these totals into the capital charge calculation as follows:

$$K_{TSA} = \frac{(3.75 + 5.4 + 7.05)}{3} = 5.4$$

Thus, Gamma Bank must hold $540 million in operational risk capital under Basel II using the standardized approach.

Example 2: Calculating TSA capital charge

If Delta Bank has negative revenue in any business line, it can offset capital charges that year up to a maximum benefit of zero capital. Beta Bank has had the following revenue (in $100 millions) for the past three years for its two lines of business: corporate finance and retail banking.

Business Line	*Year 1*	*Year 2*	*Year 3*
Corporate Finance	5	10	15
Retail Banking	5	–25	5

Calculate the operational risk capital requirement under TSA.

Answer:

Business Line	*Year 1*	*Year 2*	*Year 3*
Corporate Finance	5 × 18% = 0.90	10 × 18% = 1.80	15 × 18% = 2.7
Retail Banking	5 × 12% = 0.60	–25 × 12% = –3.0	5 × 12% = 0.60
Total	1.5	–1.2	3.3

Because a negative number cannot be used in the numerator, we replace –1.2 in Year 2 with zero. However, unlike the BIA, the number of years remains at three. Entering these totals into the capital charge calculation yields:

$$K_{TSA} = \frac{(1.5 + 0 + 3.3)}{3} = 1.6$$

Thus, Delta Bank would hold $160 million operational risk capital under Basel II using the standardized approach.

Alternative Standardized Approach

Under Basel II, a bank can be permitted to use the alternative standardized approach (ASA) provided it can demonstrate an ability to minimize double counting of certain risks. The ASA is identical to the standardized approach except for the calculation methodologies in the retail and commercial banking business lines. For these business lines, gross income is replaced with loans and advances times a multiplier, which is set equal to 0.035. Under the ASA, the beta factor for both retail and commercial banking is set to 15%. The capital requirement for the retail banking business line, K_{RB}, (which is the same for commercial banking) is computed as follows:

$$K_{RB} = \beta_{RB} \times LA_{RB} \times m$$

where:
β_{RB} = beta factor for retail banking business line (15%)
LA_{RB} = average total outstanding retail loans and advances over the past three years
m = multiplier (0.035)

Unanticipated Results from Negative Gross Income

The BIA and TSA capital charge methodologies can produce inappropriate results when accounting for negative gross income. For example, consider the following gross income amounts multiplied by the corresponding beta factors (in $100 millions):

Business Line	*Year 1*	*Year 2*	*Year 3*
Corporate Finance	5 × 18% = 0.9	10 × 18% = 1.8	–15 × 18% = –2.7
Retail Banking	5 × 12% = 0.6	–25 × 12% = –3	5 × 12% = 0.6
Total	1.5	–1.2	–2.1

Under this scenario, the standardized approach will compute a capital charge of $50 million as follows:

$$K_{TSA} = \frac{(1.5+0+0)}{3} = 0.5$$

However, recall that the BIA applies a fixed 15% of gross income and reduces the value of *n* when negative gross income is present. Thus, under the same scenario, the BIA will compute a capital charge of $150 million as follows:

$$K_{BIA} = \frac{[(5+5)\times 0.15]}{1} = 1.5$$

Therefore, this bank would hold only $50 million in operational risk capital using TSA but $150 million under the BIA. The Basel Committee has recognized that capital under Pillar 1 (minimum capital requirements) may be distorted and, therefore, recommends that additional capital should be added under Pillar 2 (supervisory review) if negative gross income leads to unanticipated results.

Advanced Measurement Approach

LO 43.2: Describe the modeling requirements for a bank to use the Advanced Measurement Approach (AMA).

The advanced measurement approach (AMA) allows banks to construct their own models for calculating operational risk capital. Although the Basel Committee allows significant flexibility in the use of the AMA, there are three main requirements. A bank must:

- Demonstrate an ability to capture potentially severe "fat-tail" losses (banks must use 99.9th percentile events with a one-year time horizon).
- Include internal loss data, external loss data, scenario analysis, and business environment internal control factors (i.e., the four data elements).
- Allocate capital in a way that incentivizes good behavior (i.e., create incentives to improve business line operational risk management).

Under the AMA, capital requirements should be made for all seven risk categories specified by Basel II. Some firms calculate operational risk capital at the firm level and then allocate down to the business lines, while others calculate capital at the business line level. Capital

calculations are typically performed by constructing a business line/event type matrix, where capital is allocated based on loss data for each matrix cell.

Additional quantitative requirements under the AMA include:

- The approach must capture all expected and unexpected losses and may only exclude expected losses under certain criteria as stated in Basel II.
- The approach must provide sufficient detail to ensure that fat-tail events are captured.
- The bank must sum all calculated cells in the business line/event type matrix and be able to defend any correlation assumptions made in its AMA model.
- All four data elements must be included in the model, including the use of internal and external data, scenario analysis, and business environment factors.
- The bank must use appropriate weights for the four data elements when determining operational risk capital.

While the four data elements must be considered in the capital calculations, many banks use some of these elements only to allocate capital or perform stress tests, and then adjust their models, rather than using them as direct inputs into capital calculations. Regulators have accepted many different types of AMA models, such as the loss distribution approach, given the rapid development of modeling operational risk capital.

Loss Distribution Approach

LO 43.3: Describe the loss distribution approach to modeling operational risk capital.

The **loss distribution approach** (LDA) relies on internal losses as the basis of its design. A simple LDA model uses internal losses as direct inputs with the remaining three data elements being used for stressing or allocation purposes. However, according to Basel II, a bank must have at least five years of internal loss data regardless of its model design but can use three years of data when it first moves to the AMA.

The advantage of the LDA is that it is based on historical data relevant to the firm. The disadvantage is that the data collection period is likely to be relatively short and may not capture fat-tail events. For example, no firm can produce 1,000 years of data, but the model is supposed to provide a 99.9% confidence level. Also, some firms find that they have insufficient loss data to build a model, even if they have more than five years of data. Additionally, banks need to keep in mind that historical data is not necessarily reflective of the future because firms change products, processes, and controls over time.

LO 43.4: Explain how frequency and severity distributions of operational losses are obtained, including commonly used distributions and suitability guidelines for probability distributions.

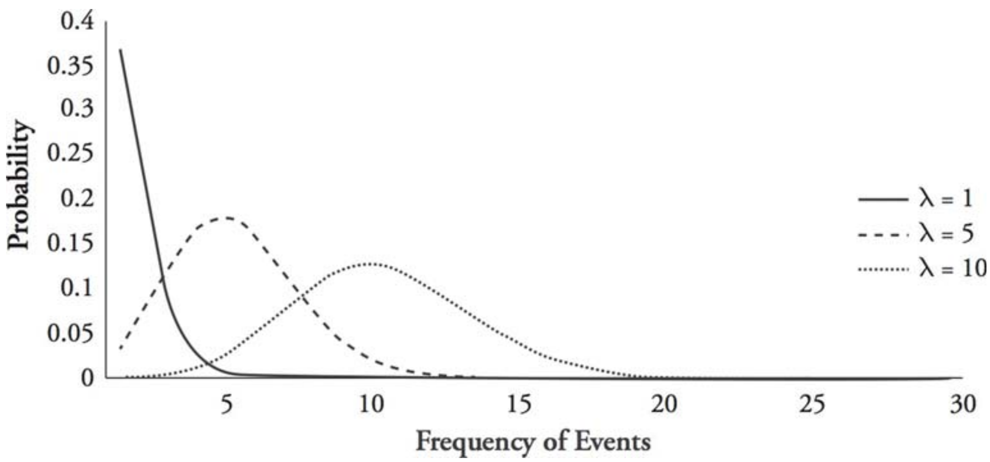
Modeling Frequency

When developing a model of expected operational risk losses, the first step is to determine the likely frequency of events on an annual basis. The most common distribution for

modeling frequency is the **Poisson distribution**. This distribution uses only one parameter, λ, which represents the average number of events in a given year, as well as the distribution's mean and variance. In an LDA model, λ can be obtained by observing the historical number of internal loss events per year and then calculating the average.

The Poisson distribution represents the probability of a certain number of events occurring in a single year. As shown in Figure 2, lower values of λ produce more skewed and leptokurtic annual loss distributions than higher values of λ.

Figure 2: Comparing Poisson Distributions

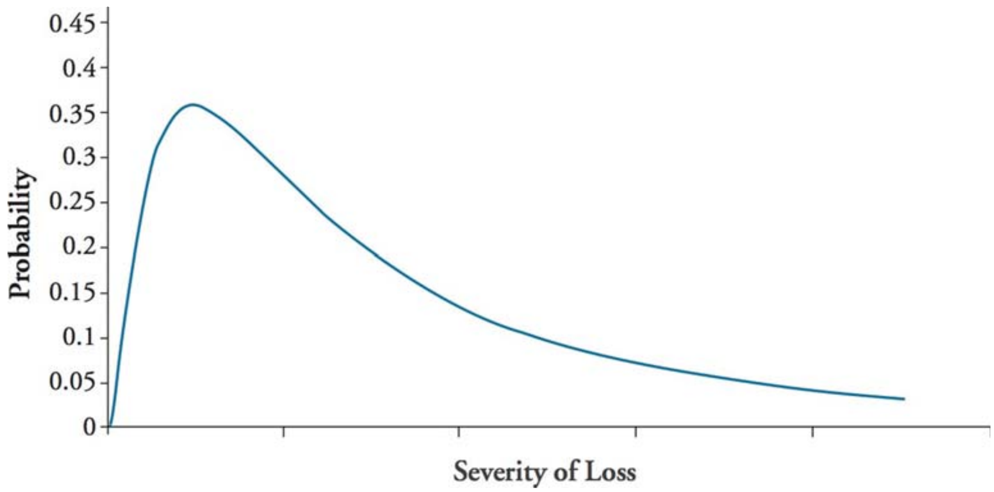


Modeling Severity

The next step in modeling expected operational risk losses is to determine the likely size (i.e., severity) of an event. The most common and least complex approach is to use a **lognormal distribution**. However, low frequency losses may be a better fit to distributions such as Generalized Gamma, Transformed Beta, Generalized Pareto, or Weibull. Regulators are interested in the selected distribution's "goodness of fit."

Regardless of the distribution selected, the probability density function must exhibit fat tails. Events that are more than three standard deviations from the mean are more likely to occur than in a normal distribution; thus, the distribution will be skewed as seen in Figure 3.

Figure 3: Example Severity Probability Distribution



Monte Carlo Simulation

LO 43.5: Explain how Monte Carlo simulation can be used to generate additional data points to estimate the 99.9th percentile of an operational loss distribution.

Once the frequency and severity distributions have been established, the next step is to combine them to generate data points that better estimate the capital required. This is done to ensure that likely losses for the next year will be covered at the 99.9% confidence level. **Monte Carlo simulation** can be used to combine frequency and severity distributions (a process known as **convolution**) in order to produce additional data points with the same characteristics as the observed data points.

With this process, we make random draws from the loss frequency data and then draw those events from the loss severity data. Each combination of frequency and severity becomes a potential loss event in our loss distribution. This process is continued several thousand times to create the potential loss distribution. To find the 99.9% confidence level, with a million observations for example, we would select the 1,000th item in an ordered list (from largest to smallest loss) to represent the maximum loss that will be experienced in a single year with 99.9% certainty.

Scenario Analysis

LO 43.6: Explain the use of scenario analysis and the hybrid approach in modeling operational risk capital.

Scenario analysis data is designed to identify fat-tail events, which is useful when calculating the appropriate amount of operational risk capital. The advantage of using scenario analysis is that data reflects the future through a process designed to consider "what if" scenarios, in contrast to the LDA which only considers the past. The major disadvantage of scenario analysis is that the data is highly subjective, and it only produces a few data points. As a result, complex techniques must be applied to model the full loss distribution,

as the lack of data output in scenario analysis can make the fitting of distributions difficult. In addition, small changes in assumptions can lead to widely different results.

There are many different approaches to scenario analysis, but whichever method is used, a scarcity of data points is likely. This makes pure scenario analysis a difficult approach to defend in estimating risk capital. Also, the more reliance there is on scenario analysis, the more robust the program must be because sometimes there is little or no loss data available and a model may need to rely purely on scenario analysis for a particular risk category. Consequently, it is acceptable to have different modeling techniques for various risk categories as long as the differences are justified. While some scenario-based models have been approved in Europe, U.S. regulators generally do not accept them.

In the **hybrid approach**, loss data and scenario analysis output are both used to calculate operational risk capital. Some firms combine the LDA and scenario analysis by stitching together two distributions. For example, the LDA may be used to model expected losses, and scenario analysis may be used to model unexpected losses. Another approach combines scenario analysis data points with actual loss data when developing frequency and severity distributions.

Insurance

Banks have the option to insure against the occurrence of operational risks. The important considerations are how much insurance to buy and which operational risks to insure. Insurance companies offer polices on everything from losses related to fire to losses related to a rogue trader. A bank using the AMA for calculating operational risk capital requirements can use insurance to reduce its capital charge. However, the recognition of insurance mitigation is limited to 20% of the total operational risk capital required.

The LDA allows for a risk profiling of an institution, which can include the risk reducing effect of insurance, which then alters the aggregate loss distribution. Typically this is done by reducing the severity of the losses that exceed a given deductible in the insurance policy. In other words, insurance typically lowers the severity but not the frequency.

Operational risk capital may need to be billions of dollars, so it can be worthwhile to pursue insurance as a means to reduce the amount of capital needed. Insurance companies are attempting to accommodate industry needs through new insurance products that meet Basel requirements.

Key Concepts

LO 43.1

The three methods for calculating operational risk capital requirements are (1) the basic indicator approach (BIA), (2) the standardized approach (TSA), and (3) the advanced measurement approach (AMA). Large banks are encouraged to move from TSA to the AMA in an effort to reduce capital requirements.

LO 43.2

The first requirement to use the AMA is that the model must hold sufficient capital to cover all operational risk losses for one year with a certainty of 99.9%. The second requirement is that internal loss data, external loss data, scenario analysis, and business environment internal control factors must be included in the model. The third requirement is that there must be a method for allocating capital that incentivizes good behavior.

LO 43.3

The loss distribution approach (LDA) relies on internal losses as the basis of its design. It uses internal losses as direct inputs, with the remaining data elements being used for stressing or allocation purposes. However, regardless of its model design, a bank must have at least three years of loss data. The advantage of the LDA model is that it is based on historical data relevant to the firm. The disadvantage is that the data collection period is likely to be relatively short and may not capture all fat-tail events.

LO 43.4

When developing a model of expected operational risk losses, the first step is to determine the likely frequency of events on an annual basis. The most popular distribution for modeling frequency is the Poisson distribution. In a Poisson distribution, there is only one parameter, λ, which represents the average number of events in a given year. The next step in modeling expected operational risk losses is to determine the severity of an event. The most common and least complex distribution is to use a lognormal distribution.

LO 43.5

Once the frequency and severity distributions have been established, the next step is to use them to generate data points to better estimate the capital required at a 99.9% confidence level. Monte Carlo simulation is a method for combining frequency and severity distributions to produce additional data points that have the same characteristics as observed data points.

LO 43.6

Scenario analysis data is designed to identify fat-tail events and is useful in calculating the appropriate amount of operational risk capital. In the hybrid approach, loss data and scenario analysis output are both used to calculate operational risk capital.

Concept Checkers

1. Under the basic indicator approach (BIA), what is Alpha Bank's capital charge if it has revenues of \$100 million, \$150 million, and \$200 million in the first three years?
   A. \$22.0 million.
   B. \$22.5 million.
   C. \$23.0 million.
   D. \$23.5 million.

2. Which of the following statements is not a requirement to apply the advanced measurement approach (AMA)?
   A. The model must hold capital to cover all operational risk losses for one year with a certainty of 99.9%.
   B. Internal loss data, external loss data, scenario analysis, and business environment internal control factors must be included in the model.
   C. Capital must be allocated to minimize risk.
   D. There must be a method for allocating capital that incentivizes good behavior.

3. Which of the following reasons is not a disadvantage of the loss distribution approach (LDA) to modeling operational risk capital requirements?
   A. The LDA is based on historical data.
   B. Most firms have limited historical data.
   C. Fat-tail events may not be captured by modeling.
   D. Historical data is not reflective of the future.

4. When modeling risk frequency, it is common to:
   A. use a Poisson distribution.
   B. assume that risks are highly correlated.
   C. assume risk frequency and severity are the same.
   D. use a straight-line projection from the most recent loss data.

5. Extreme losses in the tail of the operational risk loss distribution most likely follow which type of process/distribution?
   A. Generalized Pareto distribution.
   B. Historical simulation method.
   C. Poisson distribution.
   D. Extreme value theory.

Concept Checker Answers

1. **B** The BIA is based on 15% of the bank's annual gross income over a three-year period and is computed as follows:

$$K_{BIA} = \frac{[(100 + 150 + 200) \times 0.15]}{3} = \$22.5 \text{ million}$$

2. **C** There is no specific requirement under the AMA to minimize risk.

3. **A** An advantage of the LDA model is that it is based on historical data relevant to the firm.

4. **A** It is common to use a Poisson distribution to model loss frequency. A Poisson distribution has a single parameter, λ, which can be varied to accurately describe loss data.

5. **A** The most common and least complex approach for modeling extreme losses is to use a lognormal distribution. However, low frequency losses may be a better fit to distributions such as Generalized Gamma, Transformed Beta, Generalized Pareto, or Weibull.

The following is a review of the Operational and Integrated Risk Management principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

Standardized Measurement Approach for Operational Risk

Topic 44

Exam Focus

The focus of this topic is on the calculation of the standardized measurement approach (SMA). In particular, candidates should understand how the business indicator (BI) is derived and how buckets are used to group banks by size such that the BI will have a different impact on the SMA given a bank's bucket. Candidates should also know how to calculate the internal loss multiplier and the loss component, along with understanding how this component impacts the SMA given a bank's bucket classification. The SMA has evolved over time from earlier approaches that were more model-based and allowed too much flexibility. Candidates should also be familiar with the Basel Committee's outline of general and specific criteria applicable to operational loss data.

The Standardized Measurement Approach

LO 44.1: Explain the elements of the proposed Standardized Measurement Approach (SMA), including the business indicator, internal loss multiplier and loss component, and calculate the operational risk capital requirement for a bank using the SMA.

The **standardized measurement approach** (SMA) represents the combination of a financial statement operational risk exposure proxy (termed the business indicator, or BI) and operational loss data specific for an individual bank. Because using only a financial statement proxy such as the BI would not fully account for the often significant differences in risk profiles between medium to large banks, the historical loss component was added to the SMA to account for future operational risk loss exposure. As such, the loss component serves to both enhance the SMA's sensitivity to risk and to offer an incentive for a bank to improve on its operational risk management practices. A bank will be required to hold less in operational risk regulatory capital with fewer operational risk losses and a more effective risk management system.

The Business Indicator

The **business indicator** (BI) incorporates most of the same income statement components that are found in the calculation of gross income (GI). A few differences include:

- Positive values are used in the BI (versus some components incorporating negative values into the GI).
- The BI includes some items that tie to operational risk but are netted or omitted from the GI calculation.

The SMA calculation has evolved over time, as there were several issues with the first calculation that were since remedied with the latest version. These items include:

- Modifying the service component to equal max(fee income, fee expense) + max(other operating income, other operating expense). This change still allowed banks with large service business volumes to be treated differently from banks with small service businesses, while also reducing the inherent penalty applied to banks with both high fee income and high fee expenses.
- Including dividend income in the interest component, which alleviated the differing treatment among institutions as to where dividend income is accounted for on their income statements.
- Adjusting the interest component by the ratio of the net interest margin (NIM) cap (set at 3.5%) to the actual NIM. Before this adjustment, banks with high NIMs (calculated as net interest income divided by interest-earning assets) were penalized with high regulatory capital requirements relative to their true operational risk levels.
- For banks with high fee components (those with shares of fees in excess of 50% of the unadjusted BI), modifying the BI such that only 10% of the fees in excess of the unadjusted BI are counted.
- Netting and incorporating all financial and operating lease income and expenses into the interest component as an absolute value to alleviate inconsistent treatment of leases.

Business Indicator Calculation

The BI is calculated as the most recent three-year average for each of the following three components:

$$BI = ILDC_{avg} + SC_{avg} + FC_{avg}$$

where:
ILDC = interest, lease, dividend component
SC = services component
FC = financial component

The three individual components are calculated as follows, using three years of average data:

$$\text{interest, lease, dividend component (ILDC)} = \min[\text{abs}(II_{avg} - IE_{avg}), 0.035 \times IEA_{avg}] + \text{abs}(LI_{avg} - LE_{avg}) + DI_{avg}$$

where:
abs = absolute value
II = interest income (excluding operating and finance leases)
IE = interest expenses (excluding operating and finance leases)
IEA = interest-earning assets
LI = lease income
LE = lease expenses
DI = dividend income

services component (SC) =

$$\max(OOI_{avg}, OOE_{avg}) + \max\{abs(FI_{avg} - FE_{avg}), \min[\max(FI_{avg}, FE_{avg}), 0.5 \times uBI + 0.1 \times (\max(FI_{avg}, FE_{avg}) - 0.5 \times uBI)]\}$$

where:
OOI = other operating income
OOE = other operating expenses
FI = fee income
FE = fee expenses
uBI = unadjusted business indicator =

$$ILDC_{avg} + \max(OOI_{avg}, OOE_{avg}) + \max(FI_{avg}, FE_{avg}) + FC_{avg}$$

financial component (FC) =

$$abs(\text{net } P\&LTB_{avg}) + abs(\text{net } P\&LBB_{avg})$$

where:
P&L = profit & loss statement line item
TB = trading book
BB = banking book

For the purposes of calculating the SMA, banks (based on their size for the BI component) are divided into five buckets as shown in Figure 1.

Figure 1: BI Buckets

Bucket	*BI Range*	*BI Component*
1	€0 billion–€1 billion	0.11 × BI
2	€1 billion–€3 billion	€110 million + 0.15(BI – €1 billion)
3	€3 billion–€10 billion	€410 million + 0.19(BI – €3 billion)
4	€10 billion–€30 billion	€1.74 billion + 0.23(BI – €10 billion)
5	€30 billion – +∞	€6.34 billion + 0.29(BI – €30 billion)

While a bank's internal losses are not factored in for the bucket 1 group, internal losses are factored in for banks in buckets 2–5 to the extent that they allow for differentiation among banks with different risk profiles. As is evident from Figure 1, there is both a linear increase in the BI component within a given bucket and an increase in the marginal impact (i.e., 0.11 for bucket 1, 0.15 for bucket 2, etc.) of the BI for banks in higher versus lower buckets.

The BI component calculation should exclude all of the following P&L items: administrative expenses, recovery of administrative expenses, impairments and impairment reversals, provisions and reversals of provisions (unless they relate to operational loss events), fixed asset and premises expenses (unless they relate to operational loss events), depreciation and amortization of assets (unless it relates to operating lease assets), expenses tied to share capital repayable on demand, income/expenses from insurance or reinsurance businesses, premiums paid and reimbursements/payments received from insurance or reinsurance policies, goodwill changes, and corporate income tax.

Internal Loss Multiplier Calculation

Through the addition of a loss component, the SMA becomes more sensitive to risk than it would be with just the BI component alone. As highlighted above, internal losses become a relevant factor for banks in buckets 2–5. Internal losses are factored into the SMA calculation via the **internal loss multiplier**, which is calculated as follows:

$$\text{internal loss multiplier} = \ln\left(e^1 - 1 + \frac{\text{loss component}}{\text{BI component}}\right)$$

where:
loss component =
7 × average total annual loss
+ 7 × average total annual loss only including loss events above €10 million
+ 5 × average total annual loss only including loss events above €100 million

The **loss component** serves to reflect the operational loss exposure based on a bank's internal loss experiences. To differentiate between banks with similar average loss totals but differing loss distributions, the loss component distinguishes between smaller loss events versus those above €10 million and €100 million. The logarithmic function contained within the internal loss multiplier suggests that it increases at a decreasing rate (with the loss component) and has a lower bound equal to: [$\ln(e^1 - 1) = 0.541$].

Ideally, a bank will have 10 years of quality data to calculate the averages that go into the loss component calculation. If 10 years are not available, then during the transition to the SMA calculation, banks may use 5 years and add more years as time progresses until they reach the 10-year requirement. If a bank does not have 5 years of data, then the BI component becomes the only component of the SMA calculation.

A bank whose exposure is considered average relative to its industry will have a loss component equivalent to its BI component; this implies an internal loss multiplier equal to one and an SMA capital requirement equal to its BI component. If a bank's loss experience is greater (less) than the industry average, its loss component will be above (below) the BI component and its SMA capital will be above (below) the BI component.

SMA Capital Requirement Calculation

The SMA is used to determine the operational risk capital requirement and is calculated as follows:

For BI bucket 1 banks:

SMA capital = BI component

For BI bucket 2–5 banks:

SMA capital = 110M + (BI component – 110M) × internal loss multiplier

The amounts used in the BI component, which are bucket-dependent, will follow the equations shown in the BI component column of Figure 1. The internal loss multiplier is calculated per the previous section.

For banks that are part of a consolidated entity, the SMA calculations will incorporate fully consolidated BI amounts (netting all intragroup income and expenses). At a subconsolidated level, the SMA uses BI amounts for the banks that are consolidated at that particular level. At the subsidiary level, the SMA calculations will use the BI amounts from the specific subsidiary. If the BI amounts for a subsidiary or subconsolidated level reach the bucket 2 level, the banks must incorporate their own loss experiences (not those of other members of the group). If a subsidiary of a bank in buckets 2–5 does not meet the qualitative standards associated with using the loss component, the SMA capital requirement is calculated using 100% of the BI component.

It is possible that the Committee will consider an alternative to the calculation of the internal loss multiplier shown earlier, which would replace the logarithmic function with a maximum multiple for the loss component. The formula for the internal loss multiplier would then be updated as:

$$\left(\frac{m \times LC + (m-1) \times BIC}{LC + (2m-2) \times BIC}\right)$$

where:
m = factor to be calibrated
LC = loss component
BIC = business indicator component

Example: Computing the SMA Capital Requirement

PS Bank Inc., has a BI of €18.48 million for the current fiscal year. **Calculate** PS Bank's capital requirement with the standardized measurement approach.

Answer:

PS Bank is a bucket 1 bank because its BI falls within the range of €0 billion–€1 billion. For bucket 1 banks, the only component of the SMA calculation is the BI component and the calculation is: 0.11 × €18.48 million, or €2.03 million.

SMA vs. Earlier Operational Risk Capital Approaches

LO 44.2: Compare the SMA to earlier methods of calculating operational risk capital, including the Alternative Measurement Approaches (AMA), and explain the rationale for the proposal to replace them.

Before the development of the SMA, banks were using either the advanced measurement approach (AMA), the standardized approach (TSA), or its variation, the alternative standardized approach (ASA), to assess operational risk. The advanced measurement

approach, which was introduced as part of the Basel II framework in 2006, allowed for the estimation of regulatory capital based on a range of internal modeling practices. This approach was a principles-based framework allowing for significant flexibility. Although the hope of the Basel Committee was for best practices to emerge as flexibility declined, this never happened and challenges associated with comparability among banks (due to a wide range of modeling practices) and overly complex calculations remained.

Given these challenges, the Basel Committee set a goal of creating a new measure to allow for greater comparability and less complexity relative to prior methods. The SMA was created as this measure, with the intent of providing a means of assessing operational risk that would include both a standardized measure of operational risk and bank-specific loss data. Unlike AMA, the SMA is a single, non-model-based method used to estimate operational risk capital that combines financial statement information with the internal loss experience of a specific bank. The SMA is to be applied to internationally active banks on a consolidated basis, whereas it is optional for non-internationally active institutions. Although it is a relatively new measure, the SMA combines key elements of the standardized approach along with an internal loss experience component that was central to older approaches.

Identification, Collection, and Treatment of Operational Loss Data

LO 44.3: Describe general and specific criteria recommended by the Basel Committee for the identification, collection, and treatment of operational loss data.

Banks that incorporate the loss component into the SMA calculation must follow the following general criteria:

- Documented processes and procedures must be in place for the identification, collection, and treatment of internal loss data.
- A bank must maintain information on each operational risk event, including gross loss amounts, the date of occurrence (when the event first began or happened), the date of discovery (when the bank became aware of the event), the date of accounting (when the reserve, loss, or loss provision was first recognized in the bank's income statement, any gross loss amount recoveries, and what the drivers were of the loss event itself).
- Specific criteria must exist for loss data assignments stemming from centralized function events and related events over time (considered grouped losses).
- For the purposes of calculating minimum regulatory capital per the SMA framework, operational risk losses tied to credit risk will be excluded from the calculation. Operational risk losses tied to market risk will be included in the SMA calculation.
- A bank has to be able to document any criteria used to allocate losses to specific event types. In addition, a bank must be able to categorize historical internal loss data into the appropriate Level 1 supervisory categories per the Basel II Accord (Annex 9) and be prepared to provide this to supervisors when requested.
- An observation period of 10 years must be used as a basis for internally generated loss data calculations. On an exception basis and as long as good-quality data is not available for more than a five-year period, a bank first moving to the SMA can use a five-year observation period.
- Internal loss data must be comprehensive in nature and capture all material exposures and activities across all geographic locations and subsystems. When a bank first moves to the SMA, a €20,000 de minimis gross loss threshold is acceptable. Afterward, this threshold is lowered to €10,000.

In addition to the general criteria noted previously, specific criteria must also be followed as described as follows:

- A policy must exist for each bank that sets the criteria for when an operational risk event or loss (which is recorded in the internal loss event database) is included in the loss data set for calculating the SMA regulatory capital amount (i.e., the SMA loss data set).
- For all operational loss events, banks must be able to specifically identify gross loss amounts, insurance recoveries, and non-insurance recoveries. A gross loss is a loss before any recoveries, while a net loss takes into account the impact of recoveries. The SMA loss data cannot include losses net of insurance recoveries.
- In calculating the **gross loss** for the SMA loss data set, the following components must be *included*:
  - External expenses (legal fees, advisor fees, vendor costs, etc.) directly tied to the operational risk event itself and any repair/replacement costs needed to restore the bank to the position it was in before the event occurring.
  - Settlements, impairments, write-downs, and any other direct charges to the bank's income statement as a result of the operational risk event.
  - Any reserves or provisions tied to the potential operational loss impact and booked to the income statement.
  - Losses (tied to operational risk events) that are definitive in terms of financial impact but remain as pending losses because they are in transition or suspense accounts not reflected on the income statement. Materiality will dictate whether the loss is included in the data set.
  - Timing losses booked in the current financial accounting period that are material in nature and are due to events that give rise to legal risk and cross more than one financial accounting period.
- In calculating the gross loss for the SMA loss data set, the following components must be *excluded*:
  - The total cost of improvements, upgrades, and risk assessment enhancements and initiatives that are incurred after the risk event occurs.
  - Insurance premiums.
  - The costs associated with general maintenance contracts on property, plant, and equipment (PP&E).
- For every reporting year of the SMA regulatory capital, the gross losses included in the loss data set must incorporate any financial adjustments (additional losses, settlements, provision changes) made within the year for risk events with reference dates up to 10 years before that reporting year. The operational loss amount after adjustments must then be identified and compared to the €10 million and €100 million threshold.
- The only two dates a bank can use to build its SMA loss data set are the date of discovery or the date of accounting. For any legal loss events, the date of accounting (which is when the legal reserve representing the probable estimated loss) is the latest date that can be used for the loss data set.
- Any losses that are related to a common operational risk event or are related by operational risk events over time are considered grouped losses and must be entered as a single loss into the SMA loss data set.
- The circumstances, data types, and methodology for grouping data should be defined with criteria found in the individual bank's internal loss data policy. In instances where individual judgment is needed to apply the criteria, this must be clarified and documented.

Key Concepts

LO 44.1

The standardized measurement approach (SMA) includes both a business indicator (BI) component accounting for operational risk exposure and an internal loss multiplier and loss component accounting for operational losses unique to an individual bank. While the BI component is factored into the SMA for banks of all sizes, the impact it has on the SMA calculation will vary depending on where the bank is classified from buckets 1–5. The loss component is factored in for all banks classified in buckets 2–5.

LO 44.2

The older advanced measurement approach (AMA) allowed banks to use a vast range of models that were inherently more flexible for individual banks but prevented valuable comparisons among banks. From this, the SMA was created as a non-model-based approach used to assess operational risk using both financial statement measures and loss data unique to individual banks.

LO 44.3

For identifying, collecting, and accounting for operational loss data, the Basel Committee has outlined several general and specific criteria that should be used. Key general criteria include processes and procedures, documentation needed, thresholds for capturing losses, and appropriate periods. Specific criteria include how to calculate gross losses (what is included versus what is excluded), key dates used to capture the losses, how to quantify grouped losses, and policies needed.

Concept Checkers

1. The business indicator (BI) component in the standardized measurement approach (SMA) calculation for a bank with a BI of €13 billion will be closest to:
   A. €1.43 billion.
   B. €1.91 billion.
   C. €2.43 billion.
   D. €13.00 billion.

2. Which of the following items from the profit & loss (P&L) statement should be included in the BI component calculation?
   A. Administrative expenses.
   B. Insurance premiums paid.
   C. Depreciation related to capitalized equipment.
   D. Provision reversals related to operational loss events.

3. Which of the following components within the BI calculation takes into account a bank's trading and banking book P&L results?
   A. Loss component.
   B. Services component.
   C. Financial component.
   D. Interest, lease, dividend component.

4. Which of the following statements best describes a difference between the SMA and the older operational risk capital approaches?
   A. The standardized approach (TSA) and the alternative standardized approach (ASA) were variations of the SMA.
   B. The advanced measurement approach (AMA) was more flexible in its application than the SMA.
   C. The SMA accounts for internal loss experiences that were not factored into the AMA.
   D. The SMA uses a model-based methodology, while the AMA was more flexible and principles-based.

5. In deriving the SMA loss data set for an individual bank, each of the following items will most likely be included in the gross loss calculation except:
   A. legal fees of €900,000 associated with an unusual risk event.
   B. a €2 million settlement tied to a recent operational risk event.
   C. a €1.4 million reserve booked to the income statement to cover a potential operational loss.
   D. €1.75 million spent on maintenance contracts tied to the bank's property, plant, and equipment (PP&E).

Concept Checker Answers

1. **C** A bank with a BI of €13 million will fall into bucket 4, which covers a BI range of €10 billion to €30 billion. With the BI component formula of €1.74 billion + 0.23(BI – €10 billion) for bucket 4 banks, the BI component for this bank will be equal to €1.74 billion + 0.23(€13 billion – €10 billion) = €2.43 billion.

2. **D** A provision reversal would normally be excluded except when it relates to operational loss events. Each of the other three choices represents a P&L item that should be excluded from the BI component calculation.

3. **C** The formula for the financial component of the BI calculation is equal to:

   $\text{abs}(\text{net P\&LTB}_{\text{avg}}) + \text{abs}(\text{net P\&LBB}_{\text{avg}})$

   with TB representing the trading book and BB representing the banking book.

4. **B** Because banks were able to use a wide range of models for calculating the AMA, there was more flexibility to these approaches than under the new SMA. TSA and ASA were older approaches rather than variations of the SMA. AMA did account for internal losses. The SMA is non-model-based, whereas the AMA did incorporate bank-specific models.

5. **D** The costs associated with maintenance contracts for PP&E are outlined in the specific criteria for collecting operational loss data as *excluded* for the purposes of calculating the gross loss for the SMA loss data set.

The following is a review of the Operational and Integrated Risk Management principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

Parametric Approaches (II): Extreme Value

Topic 45

Exam Focus

Extreme values are important for risk management because they are associated with catastrophic events such as the failure of large institutions and market crashes. Since they are rare, modeling such events is a challenging task. In this topic, we will address the generalized extreme value (GEV) distribution, and the peaks-over-threshold approach, as well as discuss how peaks-over-threshold converges to the generalized Pareto distribution.

Managing Extreme Values

LO 45.1: Explain the importance and challenges of extreme values in risk management.

The occurrence of extreme events is rare; however, it is crucial to identify these extreme events for risk management since they can prove to be very costly. Extreme values are the result of large market declines or crashes, the failure of major institutions, the outbreak of financial or political crises, or natural catastrophes. The challenge of analyzing and modeling extreme values is that there are only a few observations for which to build a model, and there are ranges of extreme values that have yet to occur.

To meet the challenge, researchers must assume a certain distribution. The assumed distribution will probably not be identical to the true distribution; therefore, some degree of error will be present. Researchers usually choose distributions based on measures of central tendency, which misses the issue of trying to incorporate extreme values. Researchers need approaches that specifically deal with extreme value estimation. Incidentally, researchers in many fields other than finance face similar problems. In flood control, for example, analysts have to model the highest possible flood line when building a dam, and this estimation would most likely require a height above observed levels of flooding to date.

Extreme Value Theory

LO 45.2: Describe extreme value theory (EVT) and its use in risk management.

Extreme value theory (EVT) is a branch of applied statistics that has been developed to address problems associated with extreme outcomes. EVT focuses on the unique aspects of extreme values and is different from "central tendency" statistics, in which the central-limit theorem plays an important role. Extreme value theorems provide a template for estimating the parameters used to describe extreme movements.

One approach for estimating parameters is the Fisher–Tippett theorem (1928). According to this theorem, as the sample size *n* gets large, the distribution of extremes, denoted M_n, converges to the following distribution known as the **generalized extreme value (GEV) distribution**:

$$F(X \mid \xi, \mu, \sigma) = \exp\left[-\left(1 + \xi \times \frac{x - \mu}{\sigma}\right)^{-1/\xi}\right] \text{ if } \xi \neq 0$$

$$F(X \mid \xi, \mu, \sigma) = \exp\left[-\exp\left(\frac{x - \mu}{\sigma}\right)\right] \text{ if } \xi = 0$$

For these formulas, the following restriction holds for random variable *X*:

$$\left(1 + \xi \times \frac{x - \mu}{\sigma}\right) > 0$$

The parameters μ and σ are the location parameter and scale parameter, respectively, of the limiting distribution. Although related to the mean and variance, they are not the same. The symbol ξ is the tail index and indicates the shape (or heaviness) of the tail of the limiting distribution. There are three general cases of the GEV distribution:

1. $\xi > 0$, the GEV becomes a Frechet distribution, and the tails are "heavy" as is the case for the *t*-distribution and Pareto distributions.

2. $\xi = 0$, the GEV becomes the Gumbel distribution, and the tails are "light" as is the case for the normal and log-normal distributions.

3. $\xi < 0$, the GEV becomes the Weibull distribution, and the tails are "lighter" than a normal distribution.

Distributions where $\xi < 0$ do not often appear in financial models; therefore, financial risk management analysis can essentially focus on the first two cases: $\xi > 0$ and $\xi = 0$. Therefore, one practical consideration the researcher faces is whether to assume either $\xi > 0$ or $\xi = 0$ and apply the respective Frechet or Gumbel distributions and their corresponding estimation procedures. There are three basic ways of making this choice.

1. The researcher is confident of the parent distribution. If the researcher is confident it is a *t*-distribution, for example, then the researcher should assume $\xi > 0$.

2. The researcher applies a statistical test and cannot reject the hypothesis $\xi = 0$. In this case, the researcher uses the assumption $\xi = 0$.

3. The researcher may wish to be conservative and assume $\xi > 0$ to avoid model risk.

Peaks-Over-Threshold

LO 45.3: Describe the peaks-over-threshold (POT) approach.

The peaks-over-threshold (POT) approach is an application of extreme value theory to the distribution of excess losses over a high threshold. The POT approach generally requires fewer parameters than approaches based on extreme value theorems. The POT approach provides the natural way to model values that are greater than a high threshold, and in this way, it corresponds to the GEV theory by modeling the maxima or minima of a large sample.

The POT approach begins by defining a random variable X to be the loss. We define u as the threshold value for positive values of x, and the distribution of excess losses over our threshold u as:

$$F_u(x) = P\{X - u \leq x \mid X > u\} = \frac{F(x+u) - F(u)}{1 - F(u)}$$

This is the conditional distribution for X given that the threshold is exceeded by no more than x. The parent distribution of X can be normal or lognormal, however, it will usually be unknown.

Generalized Pareto Distribution

LO 45.5: Evaluate the tradeoffs involved in setting the threshold level when applying the GP distribution.

The Gnedenko-Pickands-Balkema-deHaan (GPBdH) theorem says that as u gets large, the distribution $F_u(x)$ converges to a **generalized Pareto distribution** (GPD), such that:

$$1 - \left[1 + \frac{\xi x}{\beta}\right]^{-1/\xi} \text{ if } \xi \neq 0$$

$$1 - \exp\left[-\frac{x}{\beta}\right] \text{ if } \xi = 0$$

The distribution is defined for the following regions:

$x \geq 0$ for $\xi \geq 0$ and $0 \leq x \leq -\beta/\xi$ for $\xi < 0$

The tail (or shape) index parameter, ξ, is the same as it is in GEV theory. It can be positive, zero, or negative, but we are mainly interested in the cases when it is zero or positive. Here, the beta symbol, β, represents the scale parameter.

The GPD exhibits a curve that dips below the normal distribution prior to the tail. It then moves above the normal distribution until it reaches the extreme tail. The GPD then provides a linear approximation of the tail, which more closely matches empirical data.

Since all distributions of excess losses converge to the GPD, it is the natural model for excess losses. It requires a selection of u, which determines the number of observations, N_u, in excess of the threshold value. Choosing the threshold involves a tradeoff. It needs to be high enough so the GPBdH theory can apply, but it must be low enough so that there will be enough observations to apply estimation techniques to the parameters.

VaR and Expected Shortfall

One of the goals of using the POT approach is to ultimately compute the **value at risk** (VaR). From estimates of VaR, we can derive the **expected shortfall** (a.k.a. **conditional VaR**). Expected shortfall is viewed as an average or expected value of all losses greater than the VaR. An expression for this is: $E[L_P \mid L_P > VaR]$. Because it gives an insight into the distribution of the size of losses greater than the VaR, it has become a popular measure to report along with VaR.

The expression for VaR using POT parameters is given as follows:

$$\text{VaR} = u + \frac{\beta}{\xi}\left[\left[\frac{n}{N_u}(1-\text{confidence level})\right]^{-\xi} - 1\right]$$

where:
u = threshold (in percentage terms)
n = number of observations
N_u = number of observations that exceed threshold

The expected shortfall can then be defined as:

$$\text{ES} = \frac{\text{VaR}}{1-\xi} + \frac{\beta - \xi u}{1-\xi}$$

Example: Compute VaR and expected shortfall given POT estimates

Assume the following observed parameter values:

- $\beta = 0.75$.
- $\xi = 0.25$.
- u = 1%.
- $N_u/n = 5\%$.

Compute the 1% VaR in percentage terms and the corresponding expected shortfall measure.

Answer:

$$\text{VaR} = 1 + \frac{0.75}{0.25}\left[\left[\frac{1}{0.05}(1-0.99)\right]^{-0.25} - 1\right] = 2.486\%$$

$$\text{ES} = \frac{2.486}{1-0.25} + \frac{0.75 - 0.25 \times 1}{1-0.25} = 3.981\%$$

Generalized Extreme Value and Peaks-Over-Threshold

LO 45.4: Compare and contrast generalized extreme value and POT.

Extreme value theory is the source of both the GEV and POT approaches. These approaches are similar in that they both have a tail parameter denoted ξ. There is a subtle difference in that GEV theory focuses on the distributions of extremes, whereas POT focuses on the distribution of values that exceed a certain threshold. Although very similar in concept, there are cases where a researcher might choose one over the other. Here are three considerations.

1. GEV requires the estimation of one more parameter than POT. The most popular approaches of the GEV can lead to loss of useful data relative to the POT.

2. The POT approach requires a choice of a threshold, which can introduce additional uncertainty.

3. The nature of the data may make one preferable to the other.

Multivariate EVT

LO 45.6: Explain the importance of multivariate EVT for risk management.

Multivariate EVT is important because we can easily see how extreme values can be dependent on each other. A terrorist attack on oil fields will produce losses for oil companies, but it is likely that the value of most financial assets will also be affected. We can imagine similar relationships between the occurrence of a natural disaster and a decline in financial markets as well as markets for real goods and services.

Multivariate EVT has the same goal as univariate EVT in that the objective is to move from the familiar central-value distributions to methods that estimate extreme events. The added feature is to apply the EVT to more than one random variable at the same time. This introduces the concept of tail dependence, which is the central focus of multivariate EVT. Assumptions of an elliptical distribution and the use of a covariance matrix are of limited use for multivariate EVT.

Modeling multivariate extremes requires the use of copulas. Multivariate EVT says that the limiting distribution of multivariate extreme values will be a member of the family of EV copulas, and we can model multivariate EV dependence by assuming one of these EV copulas. The copulas can also have as many dimensions as appropriate and congruous with the number of random variables under consideration. However, the increase in the dimensions will present problems. If a researcher has two independent variables and classifies univariate extreme events as those that occur one time in a 100, this means that the researcher should expect to see one multivariate extreme event (i.e., both variables taking extreme values) only one time in $100 \times 100 = 10{,}000$ observations. For a trinomial distribution, that number increases to 1,000,000. This reduces drastically the number of multivariate extreme observations to work with, and increases the number of parameters to estimate.

Key Concepts

LO 45.1

Estimating extreme values is important since they can be very costly. The challenge is that since they are rare, many have not even been observed. Thus, it is difficult to model them.

LO 45.2

Extreme value theory (EVT) can be used to model extreme events in financial markets and to compute VaR, as well as expected shortfall.

LO 45.3

The peaks-over-threshold (POT) approach is an application of extreme value theory. It models the values that occur over a given threshold. It assumes that observations beyond the threshold follow a generalized Pareto distribution whose parameters can be estimated.

LO 45.4

The GEV and POT approach have the same goal and are built on the same general principles of extreme value theory. They even share the same shape parameter: ξ.

LO 45.5

The parameters of a generalized Pareto distribution (GPD) are the scale parameter β and the shape parameter ξ. Both of these can be estimated using maximum-likelihood technique

When applying the generalized Pareto distribution, the researcher must choose a threshold. There is a tradeoff because the threshold must be high enough so that the GPD applies, but it must be low enough so that there are sufficient observations above the threshold to estimate the parameters.

LO 45.6

Multivariate EVT is important because many extreme values are dependent on each other, and elliptical distribution analysis and correlations are not useful in the modeling of extreme values for multivariate distributions. Modeling multivariate extremes requires the use of copulas. Given that more than one random variable is involved, modeling these extremes can be even more challenging because of the rarity of multiple extreme values occurring at the same time.

Concept Checkers

1. According to the Fisher-Tippett theorem, as the sample size *n* gets large, the distribution of extremes converges to:
   A. a normal distribution.
   B. a uniform distribution.
   C. a generalized Pareto distribution.
   D. a generalized extreme value distribution.

2. The peaks-over-threshold approach generally requires:
   A. more estimated parameters than the GEV approach and shares one parameter with the GEV.
   B. fewer estimated parameters than the GEV approach and shares one parameter with the GEV.
   C. more estimated parameters than the GEV approach and does not share any parameters with the GEV approach.
   D. fewer estimated parameters than the GEV approach and does not share any parameters with the GEV approach.

3. In setting the threshold in the POT approach, which of the following statements is the most accurate? Setting the threshold relatively high makes the model:
   A. more applicable but decreases the number of observations in the modeling procedure.
   B. less applicable and decreases the number of observations in the modeling procedure.
   C. more applicable but increases the number of observations in the modeling procedure.
   D. less applicable but increases the number of observations in the modeling procedure.

4. A researcher using the POT approach observes the following parameter values: $\beta = 0.9$, $\xi = 0.15$, $u = 2\%$ and $N_u/n = 4\%$. The 5% VaR in percentage terms is:
   A. 1.034.
   B. 1.802.
   C. 2.204.
   D. 16.559.

5. Given a VaR equal to 2.56, a threshold of 1%, a shape parameter equal to 0.2, and a scale parameter equal to 0.3, what is the expected shortfall?
   A. 3.325.
   B. 3.526.
   C. 3.777.
   D. 4.086.

Concept Checker Answers

1. **D** The Fisher-Tippett theorem says that as the sample size *n* gets large, the distribution of extremes, denoted M_n, converges to a generalized extreme value (GEV) distribution.

2. **B** The POT approach generally has fewer parameters, but both POT and GEV approaches share the tail parameter ξ.

3. **A** There is a trade-off in setting the threshold. It must be high enough for the appropriate theorems to hold, but if set too high, there will not be enough observations to estimate the parameters.

4. **B** $\text{VaR} = 2 + \frac{0.9}{0.15}\left[\left[\frac{1}{0.04}(1-0.95)\right]^{-0.15} - 1\right]$

   VaR = 1.802

5. **A** $\text{ES} = \frac{\text{VaR}}{1-\xi} + \frac{\beta - \xi u}{1-\xi} = \frac{2.560}{1-0.2} + \frac{0.3 - 0.2 \times 1}{1-0.2} = 3.325$

The following is a review of the Operational and Integrated Risk Management principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

Validating Rating Models

Topic 46

Exam Focus

This is a specialized and rather detailed topic that deals with rating system validation. There is broad coverage of both qualitative and quantitative validation concepts with greater importance being assigned to qualitative validation. For the exam, focus on best practices as well as the specific elements of qualitative and quantitative validation. Within the realm of quantitative validation, focus specifically on the concepts of calibration and discriminatory power. Note that this material is an extension of the Rating Assignment Methodologies topic from Book 2 (Topic 19).

Model Validation

LO 46.1: Explain the process of model validation and describe best practices for the roles of internal organizational units in the validation process.

According to the Basel Committee (2004)[1], a rating system (or a rating model) "comprises all of the methods, processes, controls, and data collection and IT systems that support the assessment of credit risk, the assignment of internal risk ratings, and the quantification of default and loss estimates."

To validate a rating model, a financial institution must confirm the reliability of the results produced by the model and that the model still meets the financial institution's operating needs and any regulatory requirements. The tools and approaches to validation are regularly reassessed and revised to stay current with the changing market and operating environment. The breadth and depth of validation should be consistent with the type of credit portfolios analyzed, the complexity of the financial institution, and the level of market volatility.

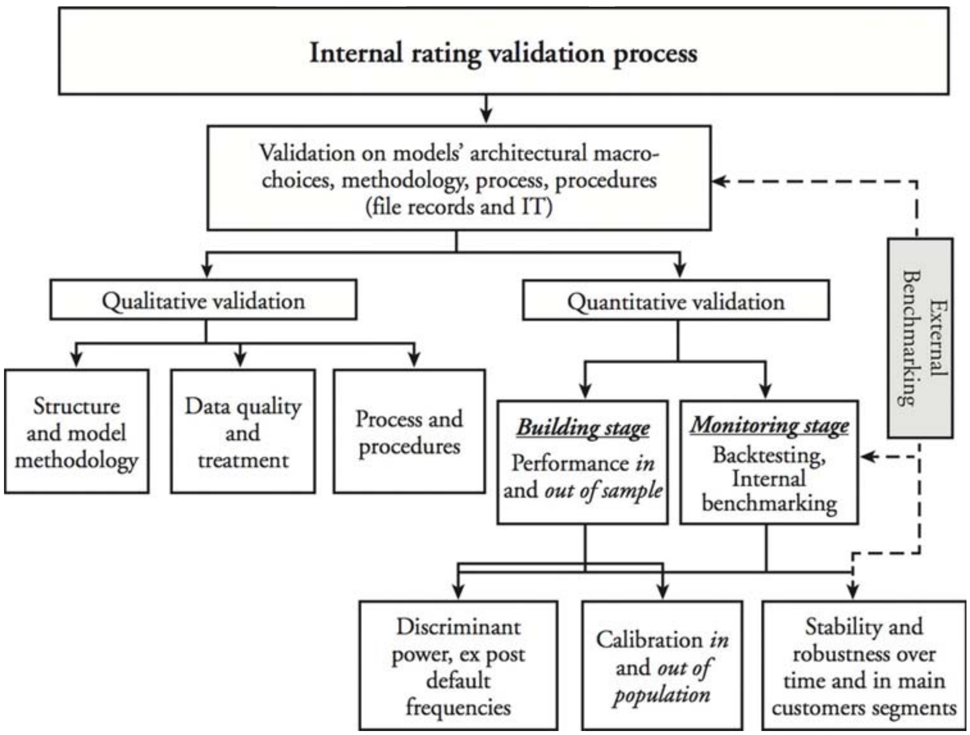
The rating model validation process includes a series of formal activities and tools to determine the accuracy of the estimates for the key risk components as well as the model's predictive power. The overall validation process can be divided between quantitative and qualitative validation. **Quantitative validation** includes comparing ex post results of risk measures to ex ante estimates, parameter calibrations, benchmarking, and stress tests. **Qualitative validation** focuses on non-numerical issues pertaining to model development such as logic, methodology, controls, documentation, and information technology.

The rating model validation process requires confirmation and method of use within the financial institution. Results must be sufficiently detailed in terms of weaknesses and limitations, in the form of reports that are forwarded regularly to the internal control group

1. Basel Committee on Banking Supervision (2004 and 2006), "International Convergence of Capital Measurement and Capital Standards," A Revised Framework, Basel, Switzerland.

and to regulatory agencies. At the same time, there must be a review of any anticipated remedies should the model prove to be weak. A summary of the overall process of model validation is provided in Figure 1.

Figure 1: Model Validation Process



Source: Figure 5.1. *Fundamental steps in rating systems validation process*. Reprinted from "Developing, Validating and Using Internal Ratings," by Giacomo De Laurentis, Renato Maino, Luca Molteni, (Hoboken, New Jersey: John Wiley & Sons, 2010), p 239.

Best Practices

The Basel Committee (2004) outlined the following two key requirements regarding corporate governance and oversight:

"All material aspects of the rating and estimation processes must be approved by the bank's board of directors or a designated committee thereof and senior management. Those parties must possess a general understanding of the bank's risk rating system and detailed comprehension of its associated management reports. Senior management must provide notice to the board of directors or a designed committee thereof of material changes or exceptions from established policies that will materially impact the operations of the bank's rating system."

"Senior management must also have a good understanding of the rating system's design and operation, and must approve material differences between established procedure and actual practice. Management must also ensure, on an ongoing basis, that the rating system is operating properly. Management and staff in the credit control function must meet regularly to discuss the performance of the rating process, areas needing improvement, and the status of efforts to improve previously identified deficiencies."

In response to these two requirements, best practices for the roles of internal organizational units in the validation process include:

1. Senior management needs to examine the recommendations that arise from the validation process together with analyzing the reports that are prepared by the internal audit group.

2. Smaller financial institutions require, at a minimum, a manager who is appointed to direct and oversee the validation process.

3. The validation group must be independent from the groups that are developing and maintaining validation models and the group(s) dealing with credit risk. The validation group should also be independent of the lending group and the rating assignment group. Ultimately, the validation group should not report to any of those groups.

4. Should it not be feasible for the validation group to be independent from designing and developing rating systems, then the internal audit group should be involved to ensure that the validation group is executing its duties with independence. In such a case, the validation group must be independent of the internal audit group.

5. In general, all staff involved in the validation process must have sufficient training to perform their duties properly.

6. Internal ratings must be discussed when management reports to or meets with the credit control group.

7. The internal audit group must examine the independence of the validation group and ensure that the validation group staff is sufficiently qualified.

8. Given that validation is mainly done using documentation received by groups dealing with model development and implementation, the quality of the documentation is important. Controls must be in place to ensure that there is sufficient breadth, transparency, and depth in the documentation provided.

A summary of the validation and control processes involving various internal organizational units is provided in Figure 2.

Figure 2: Validation and Control Processes

	Models	*Procedures*	*Tools*	*Management decision*
Basic controls	**Task:** model development and backtesting **Owner:** credit risk models development unit	**Task:** credit risk procedures maintenance **Owner:** lending units/internal control units	**Task:** operations maintenance **Owner:** lending units/IT/ internal audit	**Task:** lending policy applications **Owner:** central and decentralized units/internal control units
Second controls layer	**Task:** continuous test of models/ processes/tools performance **Owner:** lending unit/internal audit		**Task:** lending policy suitability **Owner:** validation unit/internal audit	
Third controls layer	Risk management/ CRO	Organization/ COO	Lending unit/ CLO/COO	Lending unit/ CLO/CRO
Accountability for supervisory purposes	Top management/Surveillance Board/Board of Directors			

Source: Table 5.1. *Processes and roles of validation and control of internal rating system.* Reprinted from "Developing, Validating and Using Internal Ratings," by Giacomo De Laurentis, Renato Maino, Luca Molteni, (Hoboken, New Jersey: John Wiley & Sons, 2010), p. 241.

Comparison of Qualitative and Quantitative Validation Processes

LO 46.2: Compare qualitative and quantitative processes to validate internal ratings, and describe elements of each process.

The goal of qualitative validation is to correctly apply quantitative procedures and to correctly use ratings. Qualitative and quantitative validation are complements although a greater emphasis is placed on qualitative validation given its holistic nature. In other words, neither a positive nor negative conclusion on quantitative validation is sufficient to make an overall conclusion.

Elements of Qualitative Validation

Rating systems design involves the selection of the correct model structure in context of the market segments where the model will be used. There are five key areas regarding rating systems that are analyzed during the qualitative validation process: (1) obtaining probabilities of default, (2) completeness, (3) objectivity, (4) acceptance, and (5) consistency.

Obtaining probabilities of default (PD). Using statistical models created from actual historical data allows for the determination of the PD for separate rating classes through the calibration of results with the historical data. A direct PD calculation is possible with logistic regression, whereas other methods (e.g., linear discriminant analysis) require an adjustment. An ex post validation of the calibration of the model can be done with data obtained during the use of the model. The data would allow continuous monitoring and validation of the default parameter to ensure PDs that are consistent with true economic conditions.

Completeness of rating system. All relevant information should be considered when determining creditworthiness and the resulting rating. Given that most default risk models include only a few borrower characteristics to determine creditworthiness, the validation process needs to provide assurance over the completeness of factors used for credit granting purposes. Statistical-based models allow for many borrower characteristics to be used, so there needs to be validation of the process of adding variables to the model to have greater coverage of appropriate risk factors.

Objectivity of rating system. Objectivity is achieved when the rating system can clearly define creditworthiness factors with the least amount of interpretation required. A judgment-based rating model would likely be fraught with biases (with low discriminatory power of ratings); therefore, it requires features such as strict (but reasonable) guidelines, proper staff training, and continual benchmarking. A statistical-based ratings model analyzes borrower characteristics based on actual data, so it is a much more objective model.

Acceptance of rating system. Acceptance by users (e.g., lenders and analysts) is crucial, so the validation process must provide assurance that the models are easily understood and shared by the users. In that regard, the output from the models should be fairly close to what is expected by the users. In addition, users should be educated as to the key aspects of models, especially statistical-based ones, so that they understand them and can make informed judgments regarding acceptance. Heuristic models (i.e., expert systems) are more easily accepted since they mirror past experience and the credit assessments tend to be consistent with cultural norms. In contrast, fuzzy logic models and artificial neural networks are less easily accepted given the high technical knowledge demands to understand them and the high complexity that creates challenges when interpreting the output.

Consistency of rating system. The validation process must ensure that the models make sense and are appropriate for their intended use. For example, statistical models may produce relationships between variables that are nonsensical, so the process of eliminating such variables increases consistency. The validation process would test such consistency. In contrast, heuristic models do not suffer from the same shortcoming since they are based on "real life" experiences. Statistical models used in isolation may still result in rating errors due to the mechanical nature of information processing. As a result, even though such models can remain the primary source of assigning ratings, they must be supplemented with a human element to promote the inclusion of all relevant and important information (usually qualitative and beyond the confines of the model) when making credit decisions.

Additionally, the validation process must deal with the continuity of validation processes, which includes periodic analysis of model performance and stability, analysis of model relationships, and comparisons of model outputs versus actual outcomes. In addition, the validation of statistical models must evaluate the completeness of documentation with focus on documenting the statistical foundations. Finally, validation must consider external benchmarks such as how rating systems are used by competitors.

Elements of Quantitative Validation

Quantitative validation comprises the following areas: (1) sample representativeness, (2) discriminatory power, (3) dynamic properties, and (4) calibration.

Sample representativeness. Sample representativeness is demonstrated when a sample from a population is taken and its characteristics match those of the total population. A key problem is that some loan portfolios (in certain niche areas or industries) have very low default rates, which frequently results in an overly low sample size for defaulting entities. The validation process would use bootstrap procedures that randomly create samples through an iterative process that combines items from a default group and items from a non-default group. The rating model is reassessed using the new samples; after analyzing a group of statistically created models, should the end result be stable and common among the models, then the reliability of the result is satisfied. If not, instability risk would still persist and further in-depth analysis would be required. Using more homogeneous subsets in the form of cluster analysis, for example, could provide a more stable result. Alternatively, the model could focus on key factors within the subsets or consider alternative calibrations.

Discriminatory power. Discriminatory power is the relative ability of a rating model to accurately differentiate between defaulting and non-defaulting entities for a given forecast period. The forecast period is usually 12 months for PD estimation purposes but is longer for rating validation purposes. It also involves classifying borrowers by risk level on an overall basis or by specific attributes such as industry sector, size, or geographical location.

Dynamic properties. Dynamic properties include rating systems stability and attributes of migration matrices. In fact, the use of migration matrices assists in determining ratings stability. Migration matrices are introduced after a minimum two-year operational period for the rating model. Ideal attributes of annual migration matrices include (1) ascending order of transition rates to default as rating classes deteriorate, (2) stable ratings over time (e.g., high values being on the diagonal and low values being off-diagonal), and (3) gradual rating movements as opposed to abrupt and large movements (e.g., migration rates of +/– one class are higher than those of +/– two classes). Should the validation process determine the migration matrices to be stable, then the conclusion is that ratings move slowly given their relative insensitivity to credit cycles and other temporary events.

Calibration. Calibration looks at the relative ability to estimate PD. Validating calibration occurs at a very early stage, and because of the limited usefulness in using statistical tools to validate calibration, benchmarking could be used as a supplement to validate estimates of probability of default (PD), loss given default (LGD), and exposure at default (EAD). The benchmarking process compares a financial institution's ratings and estimates to those of other comparable sources; there is flexibility permitted in choosing the most suitable benchmark.

Data Quality

LO 46.3: Describe challenges related to data quality and explain steps that can be taken to validate a model's data quality.

Challenges to Data Quality

Strong data quality is crucial when performing quantitative validation. General challenges involved with data quality include (1) completeness, (2) availability, (3) sample representativeness, (4) consistency and integrity, and (5) data cleansing procedures.

Defaults are the key constraint in terms of creating sufficiently large data sets for model development, rating quantification, and validation purposes. As a result, reliability and completeness are important issues. In addition, the definition of default needs to be consistent between the potentially wide variety of data collection sources and the Basel II definition of default.

Sample size and sample homogeneity present challenges as well. Practically speaking, it is difficult to create samples from a population over a long period using the same lending technology. **Lending technology** refers to the information, rules, and regulations used in credit origination and monitoring. In practice, it is almost impossible to have credit rules and regulations remain stable for even five years of a credit cycle. Changes occur because of technological breakthroughs that allow for more efficient handling of the credit function, market changes and new segments that require significant changes to credit policies, and merger and acquisition activity. Unfortunately, the changes result in less consistency between the data used to create the rating model and the population to which the model is applied.

The time horizon of the data may be problematic because the data should be created from a full credit cycle. If it is less than a full cycle, the estimates will be biased by the favorable or unfavorable stages during the selected period within the cycle.

Other data management issues such as outliers, missing values, and unrepresentative data may create challenges with validation.

Note that data quality involves the use of samples in the model building process. It is not easy to make inferences about the population merely from the samples used in the model. To do so, it is necessary to calibrate appropriately and do out-of-sample testing. Out-of-sample testing refers to observations created from the same lending technology but not included in the development sample.

Validating a Model's Data Quality

Validating data quality focuses on the stability of the lending technology and the degree of calibration required to infer sample results to the population. For example, if the observed in-sample default rate differs from that of the population, then the validation process should confirm that the calibration takes into account the difference. Or, if the lending technology changes due to a merger or acquisition, then the validation process must confirm the corresponding recalibration. The same confirmation of recalibration is required if there are material differences between borrowers' profiles in the sample versus the population.

An incorrect long-term average annual default rate results in an incorrect default probability, so validation must ensure that the long-term default rate is reasonably correct. Statistical central tendency is the average value to which population characteristics converge after many iterations of a given task. In applying central tendency to defaults, given relatively few defaults (i.e., few iterations) in any year during normal periods, it is not usually possible for the validation group to properly validate central tendency for at least 18 months. The time period is dependent on the markets, the nature of the lending facilities, and the characteristics of the customer segments. Validating central tendency in the long term is conducted through backtesting and stress testing.

The validation group should also watch market prices, consider information from the marketing department, and analyze significant transactions to determine appropriate benchmarks in which to compare the financial institution with its direct competitors.

LO 46.4: Explain how to validate the calibration and the discriminatory power of a rating model.

Validating Calibration

The validation process looks at the variances from the expected PDs and the actual default rates.

The Basel Committee (2005a)[2] suggests the following tests for calibration:

- Binomial test.
- Chi-square test (or Hosmer-Lemeshow).
- Normal test.
- Traffic lights approach.

The **binomial test** looks at a single rating category at a time, while the **chi-square test** looks at multiple rating categories at a time. The **normal test** looks at a single rating category for more than one period, based on a normal distribution of the time-averaged default rates. Two key assumptions include (1) mean default rate has minimal variance over time and (2) independence of default events. The **traffic lights approach** involves backtesting in a single rating category for multiple periods. Because each of the tests has some shortcomings, the overall conclusion is that no truly strong calibration tests exist at this time.

Validating Discriminatory Power

The validation process is performed ex post using backtesting of defaulting and non-defaulting items. Therefore, the concept of a longer forecast period requires that the forecast period begin further away from t = 0 and from the time the data is collected.

Validating discriminatory power can be done using the following four methods as outlined by the Basel Committee (2005a):

- Statistical tests (e.g., Fisher's r^2, Wilks' λ, and Hosmer-Lemeshow).
- Migration matrices.
- Accuracy indices (e.g., Lorentz's concentration curves and Gini ratios).
- Classification tests (e.g., binomial test, Type I and II errors, chi-square test, and normality test).

The frequency distribution of errors is key to assessing the model's forecasting reliability. With regard to error rates, validation requires an assessment of error tolerance, its calibration, and its financial impact (e.g., a false positive or Type I error increases losses, and a false negative or Type II error increases opportunity costs).

2. Basel Committee on Banking Supervision (2005a), "Studies on Validation of Internal Rating Systems," Working Papers 14, Basel, Switzerland.

Key Concepts

LO 46.1

To validate a rating model, a financial institution must confirm the reliability of the results produced by the model and that the model still meets the financial institution's operating needs and any regulatory requirements. The tools and approaches to validation are regularly reassessed and revised to stay current with the changing market and operating environment.

Best practices for the roles of internal organizational units in the validation process include active involvement of senior management and the internal audit group. In general, all staff involved in the validation process must have sufficient training to perform their duties properly.

With regard to independence, the validation group must be independent from the groups that are developing and maintaining validation models and the group(s) dealing with credit risk. The validation group should also be independent of the lending group and the rating assignment group. Ultimately, the validation group should not report to any of those groups. Given that validation is mainly done using documentation received by groups dealing with model development and implementation, the quality of the documentation is important. Controls must be in place to ensure that there is sufficient breadth, transparency, and depth in the documentation provided.

LO 46.2

There are five key areas regarding rating systems that are analyzed during the qualitative validation process: (1) obtaining probabilities of default, (2) completeness, (3) objectivity, (4) acceptance, and (5) consistency.

Quantitative validation comprises the following areas: (1) sample representativeness, (2) discriminatory power, (3) dynamic properties, and (4) calibration.

LO 46.3

Defaults are the key constraint in terms of creating sufficiently large data sets for model development, rating quantification, and validation purposes.

With regard to sample size and sample homogeneity, it is difficult to create samples from a population over a long period using the same lending technology. Lending technology is most likely to change. Unfortunately, the changes result in less consistency between the data used to create the rating model and the population to which the model is applied.

The time horizon of the data may be problematic because the data should take into account a full credit cycle. If it is less than a full cycle, the estimates will be biased by the favorable or unfavorable stages during the selected period within the cycle.

Validating data quality focuses on the stability of the lending technology and the degree of calibration required to infer sample results to the population.

LO 46.4

Validating calibration looks at the variances from the expected probabilities of default and the actual default rates. Tests of calibration include (1) binomial test, (2) chi-square test (or Hosmer-Lemeshow), (3) normal test, and (4) traffic lights approach.

Validating discriminatory power involves backtesting of defaulting and non-defaulting items. Tests of discriminatory power include (1) statistical tests, (2) migration matrices, (3) accuracy indices, and (4) classification tests.

Concept Checkers

1. Which of the following statements regarding the model validation process is most accurate?
   A. The validation process places equal importance on quantitative and qualitative validation.
   B. The validation group could be involved with the rating system design and development process.
   C. The quantitative validation process involves an analysis of structure and model methodology.
   D. The breadth and depth of validation should be commensurate primarily with the dollar value of the loans outstanding.

2. Which of the following areas of quantitative validation would focus on rating systems stability?
   A. Calibration.
   B. Discriminatory power.
   C. Dynamic properties.
   D. Sample representativeness.

3. The increasing use of heuristic rating models versus statistical rating models would most likely be covered under which area of qualitative validation?
   A. Acceptance.
   B. Completeness.
   C. Consistency.
   D. Objectivity.

4. Which of the following statements regarding the validation of data quality is correct?
   A. Data should be created from a full credit cycle.
   B. Validating central tendency in the long term is done through normality testing.
   C. In practice, it is necessary to create samples from a population over a five-year period using the same lending technology.
   D. To make inferences about the population from the samples used in a model, it is necessary to calibrate appropriately and do in-sample testing.

5. Which of the following methods would most likely be used to validate both the calibration and the discriminatory power of a rating model?
   A. Accuracy indices.
   B. Classification tests.
   C. Migration matrices.
   D. Traffic lights approach.

Concept Checker Answers

1. **B** The validation group could be involved with the rating system design and development process as long as sufficient controls are in place to ensure independence. For example, the internal audit group could confirm that the validation group is acting independently.

   There is more emphasis on qualitative validation over quantitative validation. Structure and model methodology is dealt with under *qualitative* validation, not quantitative. The breadth and depth of validation is not primarily focused on the dollar value of the loans outstanding and takes a broader approach by considering the type of credit portfolios analyzed, the complexity of the financial institution, and the level of market volatility.

2. **C** Dynamic properties include rating systems stability and attributes of migration matrices. Calibration looks at the relative ability to estimate probability of default (PD). Discriminatory power is the relative ability of a rating model to accurately differentiate between defaulting and non-defaulting entities for a given forecast period. Sample representativeness is demonstrated when a sample from a population is taken and its characteristics match those of the total population.

3. **A** Heuristic models are *more easily accepted* since they mirror past experience and the credit assessments tend to be consistent with cultural norms. In contrast, statistical models are *less easily accepted* given the high technical knowledge demands to understand them and the high complexity that creates challenges when interpreting the output.

   Completeness refers to the sufficiency in number of factors used for credit granting purposes since many default-based models use very few borrower characteristics. In contrast, statistical-based models allow for many borrower characteristics to be used. *Consistency* refers to models making sense and being appropriate for their intended use. For example, statistical models may produce relationships between variables that are nonsensical, so the process of eliminating such variables increases consistency. *Objectivity* is achieved when the rating system can clearly define creditworthiness factors with the least amount of interpretation required, choosing between judgment-based versus statistical-based models.

4. **A** If data is created from less than a full credit cycle, the estimates will be biased by the favorable or unfavorable stages during the selected period within the cycle.

   Validating central tendency in the long term is done through backtesting and stress testing. In practice, it is almost impossible to have credit rules and regulations remain stable for even five years of a credit cycle. To make inferences about the population, it is necessary to use *out-of-sample* testing whereby the observations are created from the same lending technology but were not included in the development sample.

5. **B** Classification tests include the binomial test, chi-square test, and normality test. Those tests are used to analyze discriminatory power and calibration.

   Accuracy indices and migration matrices are used only for discriminatory power. The traffic lights approach is used only for calibration.

The following is a review of the Operational and Integrated Risk Management principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

Model Risk

Topic 47

Exam Focus

Models are indispensible in modern finance in quantifying and managing asset-liability risk management, credit risk, market risk, and many other risks. Models rely on a range of data input based on a combination of historical data and risk assumptions, and are critical in managing risk exposures and financial positions. However, models rely on the accuracy of inputs, and errors give rise to model risk. Model risk can range from errors in inputs and assumptions to errors in implementing or incorrectly interpreting a model, and can result in significant losses to market participants. For the exam, be able to identify and explain common model errors, model implementation and valuation issues, and model error mitigation techniques. Also, be familiar with the two case studies discussed related to model risk: Long-Term Capital Management and the London Whale incident.

Sources of Model Risk

LO 47.1: Identify and explain errors in modeling assumptions that can introduce model risk.

Modeling is a critical component in the risk management of an organization. Models help quantify risk and other exposures as well as potential losses. However, models can be complex and are subject to **model risk**, which includes input errors, errors in assumptions, and errors in interpretation.

Model Complexity

When quantifying the risk of simple financial instruments such as stocks and bonds, model risk is less of a concern. These simple instruments exhibit less volatility in price and sensitivities relative to complex financial instruments so, therefore, their market values tend to be good indicators of asset values. However, model risk is a significantly more important consideration when quantifying the risk exposures of complex financial instruments, including instruments with embedded options, exotic over-the-counter (OTC) derivatives, synthetic credit derivatives, and many structured products. For these complex instruments, markets are often illiquid and do not provide sufficient price discovery mechanisms, which puts greater emphasis on models to value instruments, typically through a mark-to-model valuation approach. These models are important not only for valuing instruments and assessing risk exposure, but also to determine the proper hedging strategy.

As financial instruments increase in complexity, so do the models used to value them. More complex models, such as the Black-Scholes-Merton option pricing model, increased the

threat of model risk, especially for the more complex derivatives such as interest rate caps and floors, swaptions, and credit and exotic derivatives. As technology advanced, so did the complexity of the models created and used. The growth in complexity of the models also increased the reliance on these models. In addition, managers often do not have a solid understanding of the more complex models. When models are difficult to understand, the risk of model errors and the risk of incorrect vetting, interpretation, and oversight increases.

The dangers of relying too heavily on complex models became especially apparent during the 2007–2009 financial crisis. When markets endure a prolonged period of turmoil, models tend to underestimate the volatilities, correlations, and risks of financial instruments, and can overstate values, all of which may lead to sustained losses by market participants. Since models are often used for valuing instruments, a model may show that a strategy is profitable when in fact it is experiencing losses. Following the global credit crisis, model risk became more regulated as the Basel Committee mandated that financial institutions more rigorously assess model risk.

Common Model Errors

Model risk has been apparent over the last several decades through various international crises. A model may be incorrect if it contains incorrect assumptions about a financial instrument's price or risk. One example of model error was the remarkable collapse in 1997 of a hedge fund run by Victor Niederhoffer, a well-known Wall Street trader. The fund's strategy was to write (sell) deep out-of-money put options on the S&P 500, based on the assumption that the index volatility would not exceed 5% daily, and therefore, the option would expire worthless. In October 1997, the Asian financial crisis created a contagion effect that impacted North American markets. As a result, market volatilities increased significantly above historical levels. This level of volatility was not priced into the advanced mathematical models used by the fund which instead assumed a normal distribution of risk and historical correlations. The fund ultimately experienced substantial losses as its equity was completely wiped out.

Losses from model errors can be due to errors in assumptions, carelessness, fraud, or intentional mistakes that undervalue risk or overvalue profit. The six common model errors are as follows:

1. *Assuming constant volatility*. One of the most common errors in modeling is the assumption that the distribution of asset price and risk is constant. The 2007–2009 financial crisis showed just how incorrect this assumption can be, when market volatilities not predicted by models increased significantly over a short period of time.

2. *Assuming a normal distribution of returns*. Market participants frequently make the simplifying assumption in their models that asset returns are normally distributed. Practice has shown, however, that returns typically do not follow a normal distribution, because distributions in fact have fat tails (i.e., unexpected large outliers).

3. *Underestimating the number of risk factors*. Many models assume a single risk factor. A single risk factor may produce accurate prices and hedge ratios for simple products such as a callable bond. For more complex products, including many exotic derivatives (e.g., Bermuda options), models need to incorporate multiple risk factors.

4. *Assuming perfect capital markets.* Models are generally derived with the assumption that capital markets behave perfectly. Consider a delta hedge strategy that requires active rebalancing based on the assumption that the underlying asset position is continuously adjusted in response to changes in the derivatives price. This strategy will not be effective if capital markets include imperfections, including limitations on short selling, various costs (e.g., fees and taxes), and a lack of continuous trading in the markets.

5. *Assuming adequate liquidity.* Models often assume liquid markets for long or short trading of financial products at current prices. During periods of volatility, especially extreme volatility, as seen during the recent financial crisis, liquidity could decline or dry up completely.

6. *Misapplying a model.* Historically, model assumptions have worked well in most world markets, but tend to break down during periods of greater uncertainty or volatility. For example, traditional models assuming normality did not work well in many countries, including the United States, Europe, and Japan in the post financial crisis period, which has been characterized by low or negative interest rates and unconventional monetary policies including quantitative easing. In these markets, models that include other statistical tools work better.

   Similarly, models that work well for traditional assets could yield incorrect results when complex factors including embedded options are factored in. Another example of misapplying a model is to use one that was created to value bonds with no embedded options (e.g., a non-callable, non-convertible bond) to now value bonds with embedded options (e.g., a callable, convertible bond).

LO 47.2: Explain how model risk can arise in the implementation of a model.

In the previous section, we looked at the most common model errors. However, even correct models can be incorrectly implemented. This section looks at the most common implementation issues. Models may be affected by programming bugs or approximation errors, and models that seemed to work under normal conditions may have errors when tested under stressed market conditions.

Common Model Implementation Errors

Implementation error could occur, for example, when models that require Monte Carlo simulations are not allowed to run a sufficient number of simulations. In such a case, even if all the model inputs and assumptions are correct, the results may still be incorrect if insufficient time is given for the computations.

For the implementation of models, important considerations should include how frequently the model parameters need to be refreshed, including volatilities and correlations. Analysts responsible for maintaining models must consider whether adjustments should occur periodically at scheduled dates, or only when material economic events occur. Similarly, the treatment of outliers should also be considered. For example, should outliers be considered extreme outcomes only (that is, not part of the true distribution), or should they be considered part of the true distribution? Correctly answering these questions became especially important in the post-financial crisis period.

Correctly estimating parameters like durations, volatilities, and correlations is very difficult, and implementing a model with input errors will result in inaccurate results. For example, in the 1970s the investment banking firm Merrill Lynch used incorrect hedge durations for government bonds, which resulted in a considerable loss to the firm. In another example, during the stressed conditions of the financial crisis, default correlations within structured products moved toward the binary extremes of +1 or –1. In other words, the cumulative default rates of collateralized debt obligations (CDOs) either all remained below a threshold with no defaults in any tranches, or all moved above a threshold, leading to defaults of even the AAA-rated tranches.

Common Valuation and Estimation Errors

Models also rely on the accuracy of inputs and values fed into the model, and are therefore subject to human error. *Human error* is particularly of concern in new or developing markets where adequate controls have not been fully defined and implemented.

Common valuation and estimation errors include:

1. *Inaccurate data*. Models may use both internal and external data sources, where the responsibility for data accuracy is not clearly assigned. This could lead to errors from using inaccurate data.

2. *Incorrect sampling period length*. Increasing the number of observations is expected to improve data accuracy and reduce estimation errors. However, including old (and therefore obsolete) statistics could put too much weight on stale data.

3. *Liquidity and valuation problems*. Accurate pricing and valuation may not be possible in all markets. Prices for a particular asset may not exist in certain markets, or the bid-ask spread may be too high to offer accurate valuation.

Mitigating Model Risk

LO 47.3: Explain methods and procedures risk managers can use to mitigate model risk.

Model risk can be mitigated either through investing in research to improve the model or through an independent vetting process. Investing in research leads to developing better and more accurate statistical tools, both internally and externally. Independent vetting includes the independent oversight of profit and loss calculations as well as the model selection and construction process. Vetting consists of the following six phases:

1. *Documentation*. Documentation should contain the assumptions of the underlying model and include the mathematical formulas used in the model. It should contain a term sheet to describe the transaction, a mathematical statement of the model (all the variables and processes, payoff function and pricing algorithms, calibrations, and hedge ratios and sensitivities), and the implementation features, including inputs, outputs, and any numerical methods.

2. *Model soundness*. Vetting should ensure that the model used is appropriate for the financial instrument being valued. For example, a model valuing option-free bonds would not be appropriate to value convertible or callable bonds.

3. *Independent access to rates*. To facilitate independent parameter estimation, the model vetter should ensure that the middle office has access to independent financial rates.

4. *Benchmark selection*. The vetting process should include selecting the appropriate benchmark based on assumptions made. Results from the benchmark test should be compared with the results from the model test.

5. *Health check and stress test*. Models should be vetted to ensure they contain all necessary properties and parameters. Models should also be stress tested to determine the range of values for which the model provides accurate pricing.

6. *Incorporate model risk into the risk management framework*. Model risk should be considered in the formal risk management governance and framework of an institution. In addition, models need to be periodically reevaluated for relevance and accuracy. Empirical evidence suggests that simple, robust models work better than more complex and less robust models.

Case Studies Related to Model Risk

LO 47.4: Explain the impact of model risk and poor risk governance in the 2012 London Whale trading loss and the 1998 collapse of Long Term Capital Management.

The impact of model risk has been felt significantly during two specific incidents: the 1997 collapse of Long-Term Capital Management (LTCM) and the 2012 "London Whale" trading loss at JPMorgan Chase (JPM). Both incidents illustrate the necessity to closely examine and vet models, and the importance of considering model risk within an organization's institutional risk governance framework.

Long-Term Capital Management

Background and Trading Strategies

LTCM was a U.S. hedge fund that existed between 1994 and 1998. The fund raised in excess of $1 billion in capital at its inception and grew rapidly over its initial years. LTCM's trading strategy relied on arbitrage positions based on market-neutral and relative-value trading. The fund began primarily as a bond arbitrage hedge fund that sought to make money by exploiting the spread differentials between bonds, including spread differences of European sovereign bonds and spread differences of corporate bonds and government Treasuries in the United States and United Kingdom.

LTCM relied on a combination of extensive empirical research and advanced financial modeling to formulate bets on convergence of prices in bond markets. For example, the fund was long (bought) Spanish and Italian sovereign debt and was short (sold) German

sovereign debt. The strategy assumed that German sovereign bonds were overpriced relative to the weaker Spanish and Italian bonds, which were expected to increase in value with the imminent membership in the European economic and monetary union.

Another strategy was based on the expected convergence between the spreads of corporate and government bonds in the United States and United Kingdom, where spreads were expected to return to normal levels. This strategy was designed to make a profit regardless of the movement in price levels, assuming, however, that spreads moved in the appropriate direction and that correlations did not change materially.

Leverage, Correlations, and Volatility

LTCM's strategies were designed to generate only modest profits (around 1%). In order for the fund to generate strong performance, it needed to use extensive leverage of up to 25 times. Such leveraged positions relied on large institutional loans that were collateralized by bond investments. Shortly before the fund's collapse in 1998, LTCM had capital of close to $5 billion, assets of over $125 billion, and a notional value of investments in excess of $1.25 trillion. The magnitude of LTCM's leveraged investments was unprecedented in the markets.

LTCM's strategies worked as long as positions converged as anticipated, and as long as correlations did not deviate significantly from historical levels. Volatilities were calculated based on mathematical models to be approximately in line with the risk of investing in the S&P 500. However, at the time of the fund's collapse, its one-day volatility exceeded its model predicted volatility by 2.5 times, and the fund suffered losses of more than 3 times its 10-day predicted maximum loss.

Collapse and Lessons

In 1997, Asian markets experienced considerable economic and financial problems that quickly spread to several economies as contagion increased. These troubles ultimately affected Russia, which was forced to devalue its currency, the ruble, and default on its sovereign debt in August 1998. The Asian and Russian crisis triggered a flight-to-quality in European and North American markets with investors seeking the safe and predictable returns of high-quality sovereign bonds. As a result, the yields of the U.S. and German long-term sovereign bonds declined (their prices increased), while at the same time the yields on the riskier corporate bonds and riskier sovereign bonds (for example, Italy and Spain) increased (their prices fell). Credit spreads widened, volatilities increased beyond historical levels, and correlations in the market moved closer to +1 as the contagion effect of the crisis spread across markets.

With higher volatilities and dramatically widening spreads, the profits on LTCM's short positions were no longer sufficient to offset the losses on its long positions. With losses mounting, lenders demanded additional collateral. In order to meet collateral calls, LTCM had to unwind several unprofitable trades that put further downward pressure on markets given the size of the fund's trading positions. At the same time, liquidity in the markets quickly began to dry up, leaving many of LTCM's market-neutral positions now directionally exposed on the long side. Ultimately, the fund became insolvent in September 1998 and was bailed out by the Federal Reserve Bank of New York in order to curb a potential global financial crisis.

LTCM's collapse highlighted several flaws in its regulatory value at risk (VaR) calculations:

1. The fund's calculated 10-day VaR period was too short. A time horizon for economic capital should be sufficiently long enough to raise new capital, which is longer than the 10-day assumption.

2. The fund's VaR models did not incorporate liquidity assumptions. The assumption of perfectly liquid markets proved to be incorrect when the fund experienced liquidity droughts.

3. The fund's risk models did not incorporate correlation and volatility risks. This weakness was especially evident when markets moved to a correlation of close to +1 and volatility increased significantly above historical and model predicted levels.

London Whale

Background and Trading Strategy

JPMorgan Chase & Company (JPM), along with its principal banking subsidiary JPMorgan Chase Bank, is a U.S. financial company and one of the largest derivatives traders in the world. JPM garnered international headlines when in the first half of 2012 it sustained losses in excess of $6 billion due to risky synthetic credit derivatives trades executed by a trader, called the "London Whale", in its London office. The London trading desk belonged to JPM's Chief Investment Office (CIO), which was responsible for managing the bank's excess deposits.

The CIO was tasked with keeping the bank's risk level down and prudently managing the bank's $350 billion in excess deposits. Instead, the CIO used the deposits to engage in high-profit potential, high-risk derivatives trading strategies. In 2006, the CIO began a new series of synthetic credit derivatives trading strategies within its Synthetic Credit Portfolio (SCP). Trading focused less on hedging risk and more on earning profits from short positions.

Risk Culture, Model Risk, and Operational Risk

The CIO used various risk metrics for its trading activities, including VaR limits and credit spread widening limits.

In 2011, the CIO was instructed to reduce the bank's risk-weighted assets (RWA) in order to reduce regulatory capital requirements. Instead of the common practice of selling high risk assets, the CIO instead launched a trading strategy to offset its outstanding short positions by taking long positions in synthetic credit derivatives. This resulted not only in an increase in the portfolio's risk and size, but it also put the portfolio in a net long position, which reduced the hedging protection provided by the SCP.

Concurrently, in early 2012, and in response to breaching its own internal VaR limits as well as the bank's VaR limits, the CIO adopted a new VaR model which lowered its calculated VaR by 50%. The revised model allowed the CIO to remain within its VaR limit and at the same time engage in more higher-risk trading activities. However, the bank failed to seek regulatory approval of the new model. In addition, there were manual

and calculation errors when implementing the model, which led to greater model and operational risk for the bank. Ultimately, the revised VaR model was reversed later in 2012 and the previous model was reinstated.

By 2012, the SCP was losing money on its strategies. In order to minimize its reported losses, the CIO changed its derivatives valuation practices from using midpoint prices (prices at the midpoint of the bid and ask) to using more favorable prices within the bid-ask spread during each day. As the losses in the SCP strategy increased, JPM's counterparties began to dispute the CIO's values, which led to frequent collateral disputes. Ultimately, JPM's positions soured and the bank lost close to $6.2 billion.

The losses from the London Whale trade and the subsequent investigations revealed a poor risk culture at JPM. Risk limits were routinely downplayed or ignored, limit breaches were disregarded, and risk models were altered to favor riskier trading activities.

Key Concepts

LO 47.1

Model risk becomes important when quantifying the risk exposures of complex financial instruments, including exotic or synthetic derivatives and structured products. Model risk can give rise to losses from model errors, errors in assumptions, carelessness, fraud, or intentional mistakes. These errors can lead to undervaluing risk, overvaluing profit, or both. Six common model errors include:

1. Assuming constant volatility.

2. Assuming a normal distribution of returns.

3. Underestimating the number of risk factors.

4. Assuming perfect capital markets.

5. Assuming adequate liquidity.

6. Misapplying a model.

LO 47.2

Implementation error could occur when models that require complex simulations are not allowed to run a sufficient number of runs. This may result in incorrect output and therefore an incorrect interpretation of results.

For model implementation, considerations include frequency of refreshing model parameters, including volatilities and correlations. Correctly estimating parameters (durations, volatilities, and correlations) is challenging, however, implementing a model with input errors will result in inaccurate results.

Common valuation and estimation errors include:

1. Inaccurate data.

2. Incorrect sampling period length.

3. Liquidity and valuation problems.

LO 47.3

Model risk can be mitigated either through investing in research to improve the model, or through an independent vetting process. Vetting consists of six phases:

1. Documentation.

2. Vetting the soundness of the model.

3. Ensuring independent access to rates.

4. Benchmark selection.

5. Health check and stress testing of the model.

6. Incorporating model risk into the risk management framework.

LO 47.4

Long-Term Capital Management (LTCM) was a U.S. hedge fund that used arbitrage strategies to exploit spread differentials between bonds, including spread differences of European sovereign bonds and spread differences in corporate bonds and government Treasuries. LTCM's strategy was to make predictable, low returns and then amplify them using extensive leverage.

The collapse of LTCM in 1998 highlights three important lessons:

1. Utilizing a 10-day VaR period as a proxy for the time horizon for economic capital is too short. A time horizon is needed that is sufficiently long enough to model the time to raise new capital.

2. The fund's VaR models ignored the possibility that liquidity may decline or even completely dry up in periods of extreme stress.

3. The fund's risk models ignored correlation and volatility risks. Specifically, the fund did not account for stressed scenarios with material rises in volatility or an increase in positive market correlation as contagion risk spread across international economies.

In 2012, JPMorgan Chase (JPM) and its Chief Investment Office (CIO) sustained severe losses due to risky synthetic credit derivatives trades executed by its London office. The losses from the London Whale trade and the subsequent investigations highlighted a poor risk culture at JPM, giving rise to both model and operational risks across the firm. Risk limits were routinely ignored and limit breaches were disregarded.

Concept Checkers

1. A risk analyst for a mid-sized bank believes that two common errors in model building include the assumption of constant volatility of returns and the assumption of a non-normal returns distribution. The analyst is correct with regard to the assumption(s) of:
   A. volatility of returns only.
   B. non-normal returns distribution only.
   C. both volatility of returns and non-normal returns distributions.
   D. neither volatility of returns nor non-normal returns distributions.

2. Which of the following scenarios is the best example of a model error?
   A. Assuming a non-normal distribution of returns.
   B. Assuming perfectly liquid markets.
   C. Assuming variable distribution of asset price.
   D. Assuming imperfect capital markets.

3. The chief risk officer (CRO) of a European corporation recommends increasing the length of the sampling period in order to minimize model risk. However, increasing the length of the sampling period will most likely:
   A. increase estimation errors.
   B. diminish the power of the statistical test.
   C. put higher weight on obsolete information.
   D. diminish the relevance of old data.

4. Gamma Investments, LLC (Gamma) uses monthly model vetting to mitigate potential model risk. Gamma's managers recently accepted the use of a model for valuing short-term options on 30-year corporate bonds, but rejected the same model to value short-term options on three-year government bonds. The managers also frequently test proposed analytical models against a simulation approach. These model vetting techniques are examples of which of the following vetting phases?

	Accepting/rejecting a model	Testing models against simulation
A.	Health check of the model	Stress testing
B.	Soundness of a model	Stress testing
C.	Health check of the model	Benchmark modeling
D.	Soundness of a model	Benchmark modeling

5. Which of the following flaws in Long-Term Capital Management's (LTCM) value at risk (VaR) calculations were most evident following its collapse in 1998?
   I. The calculated 10-day VaR period was too short.
   II. The fund's VaR model assumed strong positive correlation.
   A. I only.
   B. II only.
   C. Both I and II.
   D. Neither I nor II.

Concept Checker Answers

1. **A** The analyst is correct with respect to the assumption of volatility of returns only. Another common model error is the assumption of a normal distribution of returns. Market participants frequently make the simplifying assumption in their models that asset returns are normally distributed. However, empirical research shows that returns tend to be non-normally distributed.

2. **B** Six common model errors include: (1) assuming constant volatility, (2) assuming a normal distribution of returns, (3) underestimating the number of risk factors, (4) assuming perfect capital markets, (5) assuming adequate liquidity, and (6) misapplying a model.

3. **C** Adding more observations to the model reduces estimation errors and improves the power of statistical tests. However, it gives greater relevance to old and potentially stale data and puts greater weight on obsolete information which may now be irrelevant.

4. **D** Accepting the model for one use but rejecting it for another (inappropriate) use is an example of vetting the soundness of the model. In other words, the model vetter (in this case the risk managers) should ensure that the mathematical model reasonably represents the asset being valued.

   Testing a proposed analytical model against a simulation approach or a numerical approximation technique is an example of benchmark modeling.

   Health check of the model ensures that the model contains all of the necessary properties. Stress testing a model uses simulations to check the model's reaction to different situations.

5. **A** LTCM's collapse highlighted several flaws in its regulatory VaR calculations. The fund relied on a VaR model that: (1) used a 10-day horizon, which proved to be too short to sufficiently model the time to raise new capital, (2) did not factor in liquidity risk (in other words, it assumed markets were perfectly liquid), and (3) did not incorporate correlation and volatility risks, where in fact markets exhibited strong positive correlation during periods of stress in 1997 and 1998.

The following is a review of the Operational and Integrated Risk Management principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

Risk Capital Attribution and Risk-Adjusted Performance Measurement

Topic 48

Exam Focus

This topic covers the application of the risk-adjusted return on capital (RAROC) approach to the allocation of economic capital. The application of a hurdle rate for capital budgeting decisions as well as an adjusted version of the traditional RAROC approach is also presented. For the exam, know the differences between economic capital and regulatory capital, and be able to compute RAROC for capital budgeting as well as adjusted RAROC. Also, be familiar with the qualitative concepts discussed, such as reasons for using economic capital to allocate risk capital, the benefits of RAROC, and best practices in implementing the RAROC approach.

Risk Capital, Economic Capital, and Regulatory Capital

LO 48.1: Define, compare, and contrast risk capital, economic capital, and regulatory capital, and explain methods and motivations for using economic capital approaches to allocate risk capital.

Risk capital provides protection against risk (i.e., unexpected losses). In other words, it can be defined as a (financial) buffer to shield a firm from the economic impact of risks taken. Should a disastrous event occur, those impacts could otherwise jeopardize the firm's financial security and its ability to remain a going concern. In short, risk capital provides assurance to the firm's stakeholders that their invested funds are safe. In most cases, risk capital and **economic capital** are treated synonymously, although an alternative definition of economic capital exists (discussed further in LO 48.3):

economic capital = risk capital + strategic risk capital

On the other hand, there are at least three distinct differences between risk capital and **regulatory capital** as follows:

1. Unlike risk capital, regulatory capital is relevant only for regulated industries such as banking and insurance.

2. Regulatory capital is computed using general benchmarks that apply to the industry. The result is a minimum required amount of capital adequacy that is usually far below the firm's risk capital.

3. Assuming that risk capital and regulatory capital are the same for the overall firm, the amounts may be different within the various divisions of the firm. From a risk capital allocation perspective, one solution is to allocate the greater of risk capital and regulatory capital to a certain division.

Professor's Note: We will examine the regulatory capital charges for credit, market, and operational risk in the Basel readings later in this book.

Given that Basel III requirements are sufficiently robust, it is probable that in certain areas (e.g., securitization), regulatory capital will be substantially higher than risk/economic capital. Although the two amounts may conflict, risk/economic capital must be computed in order to determine the economic viability of an activity or division. Assuming that regulatory capital is substantially higher than risk/economic capital for a given activity, then that activity will potentially move over to shadow banking (i.e., unregulated activities by regulated financial institutions) in order to provide more favorable pricing.

Using Economic Capital Approaches

From the perspective of financial institutions, the motivations for using economic capital are as follows:

Capital is used extensively to cushion risk. Compared to most other non-financial institutions, financial institutions can become highly leveraged (i.e., riskier) at a relatively low cost simply by accepting customer deposits or issuing debt. All of this may occur without having to issue equity. Additionally, many of the financial institutions will participate in transactions involving derivatives, guarantees, and other commitments that only require a relatively small amount of funding but always involve some risk. As a result, all of the firm's activities must be allocated an economic capital cost.

Financial institutions must be creditworthy. A unique aspect of financial institutions is that their main customers are also their main liability holders. Customers who deposit funds to a financial institution will be concerned about the default risk of the financial institution. With over-the-counter (OTC) derivatives, the concern is counterparty risk. As a result, a sufficient amount of economic capital must be maintained to provide assurance of creditworthiness.

There is difficulty in providing an external assessment of a financial institution's creditworthiness. It is challenging to provide an accurate credit assessment of a financial institution because its risk profile is likely to be constantly evolving. For example, an institution may engage in complicated hedging and derivatives transactions that could rapidly impact its liquidity. Therefore, having a sufficient store of economic capital could mitigate this problem and provide assurance of financial stability.

Profitability is greatly impacted by the cost of capital. Economic capital is similar to equity capital in the sense that the invested funds do not need to be repaid in the same manner as debt capital, for instance. In other words, economic capital serves as a reserve or a financial cushion in case of an economic downturn. As a result, economic capital is more expensive to hold than debt capital, thereby increasing the cost of capital and reducing the financial institution's profits. A proper balance between holding sufficient economic capital and partaking in risky transactions is necessary.

Risk-Adjusted Return on Capital

LO 48.2: Describe the RAROC (risk-adjusted return on capital) methodology and its use in capital budgeting.

The **risk-adjusted return on capital** (RAROC) methodology provides users with information pertaining to the risk-adjusted performance of the firm and its business units as opposed to merely the "raw" performance numbers. In measuring economic performance, this methodology involves allocating risk capital to the firm's business units and to specific transactions.

Benefits of RAROC include:

1. Performance measurement using economic profits instead of accounting profits. Accounting profits include historical and arbitrary measures such as depreciation, which may be less relevant.

2. Use in computing increases in shareholder value as part of incentive compensation (e.g., scorecards) within the firm and its divisions. The flexibility of RAROC may also allow for deferred/contingent compensation or clawbacks for subsequent poor performance.

3. Use in portfolio management for buy and sell decisions and use in capital management in estimating the incremental value-added through a new investment or discontinuing an existing investment.

4. Using risk-based pricing, which will allow proper pricing that takes into account the economic risks undertaken by a firm in a given transaction. Each transaction must consider the expected loss and the cost of economic capital allocated. Many firms use the "marginal economic capital requirement" portion of the RAROC equation for the purposes of pricing and determining incremental shareholder value.

LO 48.3: Compute and interpret the RAROC for a project, loan, or loan portfolio, and use RAROC to compare business unit performance.

The necessary amount of economic capital is a function of credit risk, market risk, and operational risk. The RAROC for a project or loan can be defined as risk-adjusted return divided by risk-adjusted capital. The basic RAROC equation is as follows:

$$\text{RAROC} = \frac{\text{after-tax expected risk-adjusted net income}}{\text{economic capital}}$$

There is a tradeoff between risk and return per unit of capital with the numerator acting as return and the denominator acting as risk. For example, a business unit's RAROC needs to be greater than its cost of equity in order to create shareholder value.

Furthermore, measures such as return on equity (ROE) or return on assets (ROA) are based on accounting book values only, and therefore are unable to account for the relevant risks. RAROC has two specific adjustments to these measures. In the numerator, it deducts expected loss (the risk factor) from the return. In the denominator, it replaces accounting capital with economic capital.

The underlying principles of the RAROC equation are similar to two other common measures of risk/return: (1) the Sharpe ratio, which equals: (expected return – risk-free rate) / standard deviation, and (2) the net present value (NPV), which equals the discounted value of future expected after-tax cash flows. The discount rate for the NPV is a risk-adjusted expected return that uses beta (captures systematic risk only) from the capital asset pricing model (CAPM). In contrast to NPV, RAROC takes into account both systematic and unsystematic risk in its earnings figure.

A more detailed RAROC equation to use for capital budgeting decisions is as follows:

$$\text{RAROC} = \frac{\begin{pmatrix}\text{expected revenues} - \text{costs} - \text{expected losses} \\ - \text{taxes} + \text{return on economic capital} \pm \text{transfers}\end{pmatrix}}{\text{economic capital}}$$

Where:

- *Expected revenues* assume no losses and *costs* refer to direct costs. *Taxes* are computed using the firm's effective tax rate and *transfers* include head office overhead cost allocations to the business unit as well as transactions between the business unit and the treasury group, such as borrowing and hedging costs.
- *Expected losses* (EL) consist mainly of expected default losses (i.e., loan loss reserve), which are captured in the numerator (i.e., higher funding cost) so there is no adjustment required in the denominator. Expected losses also arise due to market, operational, and counterparty risks.
- *Return on economic capital* refers to the return on risk-free investments based on the amount of allocated risk capital.
- *Economic capital* includes both risk capital and strategic risk capital.

Risk capital serves as a buffer against unexpected losses. It is the amount of funds that the firm must hold in reserve to cover a worst-case loss (an amount over the expected loss) at a specific confidence level that is usually 95% or more. Therefore, it is very similar to the annual value at risk (VaR).

Strategic risk capital pertains to the uncertainty surrounding the success and profitability of certain investments. An unsuccessful investment could result in financial losses and a negative reputational impact on the firm. Strategic risk capital includes goodwill and burned-out capital.

- **Goodwill** is the excess of the purchase price over the fair value (or replacement value) of the net assets recorded on the balance sheet. A premium price may exist because of the existence of valuable but unrecorded intangible assets.
- **Burned-out capital** represents the risk of amounts spent during the start-up phase of a venture that may be lost if the venture is not pursued because of low projected risk-adjusted returns. The venture may refer to a recent acquisition or an internally generated project. Burned-out capital is amortized over time as the strategic failure risk decreases.

Finally, firms may allocate risk capital to any unused risk limits (e.g., undrawn amounts on a line of credit) because risk capacity could be utilized any time. If risk capacity is utilized, the firm would then have to adjust the risk capital amount.

As mentioned, economic capital is designed to provide a cushion against *unexpected losses* at a specified confidence level. The confidence level at which economic capital is set can be viewed as the probability that the firm will be able to absorb unexpected losses over

a specified period. A simple example can help illustrate the concept of unexpected loss and how it is equal to the risk capital allocation. Assume for a given transaction that the expected loss is 20 basis points (bps) and the worst-case loss is 190 bps at a 95% confidence level over one year. Based on this information, the unexpected loss is 170 bps (excess of worst-case loss over expected loss). There is also still a 5% probability that the actual loss will exceed 190 bps.

Example: RAROC calculation

Assume the following information for a commercial loan portfolio:

- \$1.5 billion principal amount
- 7% pre-tax expected return on loan portfolio
- Direct annual operating costs of \$10 million
- Loan portfolio is funded by \$1.5 billion of retail deposits; interest rate = 5%
- Expected loss on the portfolio is 0.5% of principal per annum
- Unexpected loss of 8% of the principal amount, or \$120 million of economic capital required
- Risk-free rate on government securities is 1% (based on the economic capital required)
- 25% effective tax rate
- Assume no transfer pricing issues

Compute the RAROC for this loan portfolio.

Answer:

First, calculate the following RAROC components:

Expected revenue = 0.07 × \$1.5 billion = \$105 million
Interest expense = 0.05 × \$1.5 billion = \$75 million
Expected loss = 0.005 × \$1.5 billion = \$7.5 million
Return on economic capital = 0.01 × \$120 million = \$1.2 million

Then, apply the RAROC equation:

$$\text{RAROC} = \frac{(105 - 10 - 75 - 7.5 + 1.2 + 0) \times (1 - 0.25)}{120} = 8.56\%$$

Therefore, maintenance of the commercial loan portfolio requires an after-tax expected rate of return on equity of at least 8.56%.

Note that for capital budgeting projects, *expected* revenues and losses should be used in the numerator since the analysis is being performed on an ex ante (or before the fact) basis. In contrast, for performance evaluation purposes on an ex post (or after the fact) basis, *realized* (or actual) revenues and losses should be used.

RAROC for Performance Measurement

LO 48.4: Explain challenges that arise when using RAROC for performance measurement, including choosing a time horizon, measuring default probability, and choosing a confidence level.

Time Horizon

In computing RAROC, the focus so far has been on one period (i.e., one-year time horizon) since it is convenient from a business planning cycle perspective and it represents the probable amount of time needed for a firm to recover from a significant unexpected loss. At the same time, it is possible to look at multi-period RAROC to obtain a more accurate RAROC measure for longer-term transactions and loans. One issue that arises is how much economic capital to allocate if the risk of a transaction changes dramatically in subsequent periods. For example, using an averaging method would give rise to periods of overcapitalization and periods of undercapitalization.

Risk capital could be thought of as the firm's one-year VaR at a specific confidence level (e.g., 95% or 99%). For both credit risk and operational risk, no adjustments are required from one-year VaR to compute risk capital. For market risk, short time horizons such as one day (risk monitoring) or 10 days (regulatory capital) require adjustments to determine the correct one-year risk capital allocation.

One basic approach is the "square root of time" rule whereby one-year VaR is estimated by multiplying the one-day VaR by the square root of 252 business days in the year. This approach needs to be fine-tuned by considering that even in a worst-case scenario, the firm might only be able to reduce its risk to a core risk level to retain its status as a financially viable business for the rest of the year. Furthermore, the computation must also factor in the time needed to lower the current risk level to the core risk level (i.e., "time to reduce"). That amount of time corresponds to the relative liquidity (during difficult market conditions) of the firm's investment positions taken. As a result, a large amount of time may be required for a reasonable liquidation of the positions.

Example: Risk capital for market risk

Assume the following information where the core risk level is below the current risk level:

- Daily value at risk (VaR) = 80
- Core risk level = 60
- Days needed to reduce current risk level to core risk level = 10 (i.e., risk reduction of 2 VaR per day)
- Number of business days per year = 252

Compute the required risk capital as a percentage of annualized VaR.

Answer:

$$\text{Risk capital} = \text{square root}\left\{\begin{array}{l}\text{sum of squares +} \\ [\text{core risk level squared} \times (\text{number of business days per year} - \\ \text{days needed to reduce current to core})]\end{array}\right\}$$

$$= \text{square root}\left\{\begin{array}{l}(80^2 + 78^2 + 76^2 + 74^2 + 72^2 + 70^2 + 68^2 + 66^2 + 64^2 + 62^2) + \\ [60^2 \times (252 - 10)]\end{array}\right\}$$

$$= \text{square root}\ [50{,}740 + (3{,}600 \times 242)]$$

$$= \sqrt{921{,}940} = 960.18$$

Note that annualized VaR = 80 × square root of 252 = 1,269.96

Therefore, the risk capital required is approximately 75.6% of annualized VaR (960.18 / 1,269.96).

There is a lot of subjectivity in selecting the time horizon for RAROC calculation purposes. A longer time horizon could be selected to account for the full business cycle; it may not always increase the risk capital required since the confidence level required to maintain a firm's solvency will fall as the time horizon is increased. A key consideration with the selection of a time horizon is the fact that risk and return data for periods over one year is likely to be of questionable reliability.

Default Probability

A **point-in-time** (PIT) probability of default could be used to compute short-term expected losses and to price financial instruments with credit risk exposure. A **through-the-cycle** (TTC) probability of default is more commonly used for computations involving economic capital, profitability, and strategic decisions.

A firm's rating is more likely to change when analyzed under the PIT approach versus the TTC approach. As a result, the TTC approach results in a lower volatility of economic capital versus the PIT approach. From time to time, it is advisable to compare the result of PIT versus TTC for RAROC computations at a stable portion of the economic cycle and at the lowest portion of the cycle.

Confidence Level

In computing economic capital, the confidence level chosen must correspond with the firm's desired credit rating. A high rating such as AA or AAA would require a confidence level in excess of 99.95%, for example. Choosing a lower confidence level will reduce the amount of risk capital required/allocated and it will impact the risk-adjusted performance measures. The reduction may be dramatic if the firm is primarily exposed to operational, credit, and settlement risks where large losses are rare.

Hurdle Rate for Capital Budgeting Decisions

LO 48.5: Calculate the hurdle rate and apply this rate in making business decisions using RAROC.

Similar to internal rate of return (IRR) analysis, the use of a **hurdle rate** (i.e., after-tax weighted average cost of equity capital) is compared to RAROC in making business decisions. In general, the hurdle rate should be revised perhaps once or twice a year or when it has moved by over 10%.

The hurdle rate, h_{AT}, is computed as follows:

$$h_{AT} = \frac{[(CE \times R_{CE}) + (PE \times R_{PE})]}{(CE + PE)}$$

where:
CE = market value of common equity
PE = market value of preferred equity
R_{CE} = cost of common equity [could be derived from the capital asset pricing model (CAPM)]
R_{PE} = cost of preferred equity (yield on preferred shares)

Recall, that the CAPM formula is as follows:

$$R_{CE} = R_F + \beta_{CE}(R_M - R_F)$$

where:
R_F = risk-free rate
R_M = expected return on market portfolio
β_{CE} = firm's common equity market beta

Once the hurdle rate and the RAROC are calculated, the following rules apply:

- If RAROC > hurdle rate, there is value creation from the project and it should be accepted.
- If RAROC < hurdle rate, there is value destruction from the project and it should be rejected/discontinued.

Obviously, a shortcoming of the above rules is that higher return projects that have a RAROC > hurdle rate (accepted projects) also come with high risk that could ultimately result in losses and reduce the value of the firm. In addition, lower return projects that have a RAROC < hurdle rate (rejected projects) also come with low risk that could provide steady returns and increase the value of the firm. As a result, an adjusted RAROC measure should be computed.

Adjusted RAROC

LO 48.6: Compute the adjusted RAROC for a project to determine its viability.

RAROC should be adjusted to consider systematic risk and a consistent hurdle rate.

$$\text{Adjusted RAROC} = \text{RAROC} - \beta_E\left(R_M - R_F\right)$$

where:
R_F = risk-free rate = hurdle rate
R_M = expected return on market portfolio
β_E = firm's equity beta
$(R_M - R_F)$ = excess return over risk-free rate to account for the nondiversifiable systematic risk of the project

Therefore, the revised business decision rules are as follows:

- If adjusted RAROC > R_F, then accept the project
- If adjusted RAROC < R_F, then reject the project

Example: Adjusted RAROC

Suppose RAROC is 12%, the risk-free rate is 5%, the market return is 11%, and the firm's equity beta is 1.5. Use ARAROC to **determine** whether the project should be accepted or rejected.

Answer:

$$\text{Adjusted RAROC} = \text{RAROC} - \beta_E\left(R_M - R_F\right)$$
$$= 0.12 - 1.5(0.11 - 0.05) = 0.12 - 0.09 = 0.03$$

The project should be rejected because the ARAROC of 3% is less than the risk-free rate of 5%.

Risk Capital and Diversification

LO 48.7: Explain challenges in modeling diversification benefits, including aggregating a firm's risk capital and allocating economic capital to different business lines.

The overall risk capital for a firm should be less than the total of the individual risk capitals of the underlying business units. That is because the correlation of returns between the business units is likely to be less than +1. Such risk reduction due to diversification effects over risk types and business activities is very difficult to measure in practice. Instead of using an extremely high overall confidence level for the firm, the various business units may use lower confidence levels to avoid an excessively high aggregate risk capital amount.

For example, assume a firm is subject to only the following four types of risk (risk capital amounts are provided for each risk):

- Market risk = $400
- Credit risk = $300
- Liquidity risk = $200
- Operational risk = $500

Aggregate risk capital for the firm could be as high as $1,400 assuming a perfect correlation (i.e., sum of the four risk capital amounts). Or it could be as low as $734 assuming zero correlation (square root of the sum of squares of the four risk capital amounts). In taking into account the diversification effects, the firm's overall VaR should be computed as some value between $734 and $1,400, which is a very wide range. In addition, there is a lot of subjectivity involved in allocating the diversification benefits back to the business units in a fair manner especially since the allocation will impact the respective business units' performance measures (i.e., reduction of risk capital required).

It makes sense that a business unit with earnings or cash flows that are highly correlated to the overall firm would need to be allocated more risk capital than a business unit with earnings or cash flows that are negatively correlated (assuming similar volatility). Having business lines that are countercyclical in nature allows the overall firm to have stable earnings and to attain a given desired credit rating using less risk capital. In practice, the easiest allocation method is a pro-rata allocation based on standalone risk capital amounts.

For example, assume the following information pertaining to a business unit that engages in only two activities, A and B:

- Activity A alone requires $50 of risk capital
- Activity B alone requires $60 of risk capital
- Activities A and B together require a total of $90 of risk capital

Stand-alone capital looks at each activity independently and ignores any diversification benefits. Therefore, the stand-alone capital for Activities A and B are $50 and $60, respectively. The stand-alone capital for the business unit is $90.

Fully diversified capital takes into consideration the diversification benefits, which equal $20 ($50 + $60 – $90). For simplicity, the diversification benefit can be done on a pro-rata basis as follows: ($20 × $50) / $110 = $9.1 is allocated to Activity A and ($20 × $60) /$110 = $10.9 is allocated to Activity B. Therefore, Activities A and B have fully diversified capital of $40.9 and $48.1, respectively. Fully diversified capital should be used to determine a firm's solvency and to determine the minimum amount of risk capital required for a given activity.

Marginal capital is the extra capital needed as a result of a new activity added to the business unit. Diversification benefits are fully considered. The marginal risk capital for Activity A is $30 ($90 total – $60 for Activity B) and the marginal risk capital for Activity B is $40 ($90 total – $50 for Activity A). Total marginal risk capital ($70) is below the full risk capital of the business unit ($90). The general method for computing marginal capital of a new activity is to start with the total risk capital required for the business unit minus all of the risk capital required for the other activities. Marginal capital is useful for making active portfolio management and business mix decisions; such decisions need to fully consider diversification benefits.

In a performance measurement context, stand-alone risk capital is useful to determine incentive pay and fully diversified risk capital is useful to determine the incremental benefit due to diversification. In allocating the diversification benefits, caution must be taken especially since correlations between the risk factors usually change over time. In a more extreme situation such as a market crisis, correlations could move to –1 or +1, thereby reducing diversification benefits.

RAROC Best Practices

LO 48.8: Explain best practices in implementing an approach that uses RAROC to allocate economic capital.

Recommendations for implementing a RAROC approach are as follows:

Senior Management

The management team (including the CEO) needs to be actively involved with the implementation of a RAROC approach within the firm and promote it as a means of measuring shareholder value creation. The emphasis should be on the level of profits earned by the firm in relation to the level of risks taken as opposed to merely earning as much profit as possible.

Communication and Education

The RAROC process needs to be clearly explained to all levels of management of the firm in order to have sufficient "buy in" from management. Specifically, the process of allocating economic capital to the various business units needs to be fair and transparent in order to minimize the common concerns of excessive economic capital attribution to a given business unit. An open dialogue and debate with the various business unit leaders of issues concerning how economic capital is computed would also be helpful.

Ongoing Consultation

There are key metrics that impact the computation of economic capital. A committee consisting of members from the various business units as well as the risk management group should review these metrics periodically in order to promote fairness in the capital allocation process.

Metrics involving credit risk include: probability of default, credit migration frequencies, loss given default, and credit line usage given default. The metrics will change with time and will need to be updated accordingly. The historical period over which the metrics are adjusted is debatable—a shorter period may result in fluctuating economic capital amounts and a longer period may result in more stable amounts.

Metrics involving market risk focus on volatility and correlation, and should be updated at least monthly. Metrics involving operational risk are not as defined as they are for credit and

market risk, so therefore, involve a significant amount of subjectivity and debate. Other key metrics, like core risk level and time to reduce, should be updated annually.

Data Quality Control

Information systems collect data (e.g., risk exposures and positions) required to perform the RAROC calculations. The data collection process should be centralized with built-in edit and reasonability checks to increase the accuracy of the data. In subdividing the general duties surrounding data, the RAROC team should be responsible for the data collection process, the computations, and the reporting. The business units and the accounting department should be responsible for putting controls in place to ensure the accuracy of the data being used for the RAROC calculations.

Complement RAROC with Qualitative Factors

A qualitative assessment of each business unit could be performed using a four-quadrant analysis. The horizontal axis would represent the expected RAROC return and the vertical axis would represent the quality of the earnings based on the importance of the business unit's activities to the overall firm, growth opportunities, long-run stability and volatility of earnings, and any synergies with other business units. There are four resulting possibilities:

- Low quality of earnings, low quantity of earnings: the firm should try to correct, reduce, or shut down the activities of any of its business units in this category.
- Low quality of earnings, high quantity of earnings (managed growth): the firm should maintain any business units that currently produce high returns but have low strategic importance to the firm.
- High quality of earnings, low quantity of earnings (investment): the firm should maintain any business units that currently produce low returns but have high strategic value and high growth potential.
- High quality of earnings, high quantity of earnings: the firm should allocate the most resources to business units in this category.

Active Capital Management

Business units should submit their limit requests (e.g., economic capital, leverage, liquidity, risk-weighted assets) quarterly to the RAROC team. The RAROC team performs the relevant analysis and sets the limits in a collaborative manner that allows business units to express any objections. Senior management will then make a final decision. The treasury group will ensure the limits make sense in the context of funding limits. The restriction placed on a firm's growth due to leverage limitations helps promote the optimal use of the limited amount of capital available.

Key Concepts

LO 48.1

Risk capital is a buffer to shield a firm from the economic impacts of the risks that it takes (i.e., protect against unexpected losses). In short, it provides assurance to the firm's stakeholders that their invested funds are safe.

In most cases, risk capital and economic capital are identical; however, strategic risk capital may be added to economic capital as follows:

economic capital = risk capital + strategic risk capital

Regulatory capital is relevant only for regulated industries such as banking and insurance. It is computed using general benchmarks that apply to the industry. Assuming that risk capital and regulatory capital are the same for the overall firm, the amounts may be different within the various divisions of the firm.

For financial institutions, there are four major reasons for using economic capital to allocate risk capital:

- Capital is used extensively to cushion risk.
- Financial institutions must be creditworthy.
- Difficulty in providing an external assessment of a financial institution's creditworthiness.
- Profitability is greatly impacted by the cost of capital.

LO 48.2

Benefits of using the risk-adjusted return on capital (RAROC) approach include:

1. Performance measurement using economic profits instead of accounting profits.

2. Use in computing increases in shareholder value as part of incentive compensation (e.g., scorecards) within the firm and its divisions.

3. Use in portfolio management for buy and sell decisions and use in capital management in estimating the incremental value-added through a new investment or discontinuing an existing investment.

4. Using risk-based pricing, which will allow proper pricing that takes into account the economic risks undertaken by a firm in a given transaction.

LO 48.3

The basic RAROC equation is as follows:

$$\text{RAROC} = \frac{\text{after-tax expected risk-adjusted net income}}{\text{economic capital}}$$

A more detailed RAROC equation for capital budgeting decisions is as follows:

$$\text{RAROC} = \frac{\begin{pmatrix}\text{expected revenues} - \text{costs} - \text{expected losses} \\ - \text{taxes} + \text{return on economic capital} \pm \text{transfers}\end{pmatrix}}{\text{economic capital}}$$

LO 48.4

In computing RAROC, the focus is often on a one-year time horizon. However, it is possible to look at multi-period RAROC to obtain a more accurate RAROC measure for longer-term transactions and loans. One issue that arises is how much economic capital to allocate if the risk of a transaction changes dramatically in subsequent periods. There is a lot of subjectivity in selecting the time horizon for RAROC calculation purposes. A longer time horizon could be selected to account for the full business cycle, for example. A key consideration with the selection of a time horizon is the fact that risk and return data for periods over one year is likely to be of questionable reliability.

A point-in-time (PIT) probability of default could be used for short-term expected losses and to price financial instruments with credit risk exposure. A through-the-cycle (TTC) probability of default is more commonly used for computations involving economic capital, profitability, and strategic decisions.

In computing economic capital, the confidence level chosen must correspond with the firm's desired credit rating. Choosing a lower confidence level will reduce the amount of risk capital required/allocated and it will impact risk-adjusted performance measures.

LO 48.5

The hurdle rate is computed as follows:

$$h_{AT} = \frac{\left[(CE \times R_{CE}) + (PE \times R_{PE})\right]}{(CE + PE)}$$

Once the hurdle rate and the RAROC are calculated, the following rules apply:

- If RAROC > hurdle rate, there is value creation from the project and it should be accepted.
- If RAROC < hurdle rate, there is value destruction from the project and it should be rejected/discontinued.

LO 48.6

RAROC should be adjusted to take into account systematic risk and a consistent hurdle rate as follows:

$$\text{Adjusted RAROC} = \text{RAROC} - \beta_E\left(R_M - R_F\right)$$

LO 48.7

The overall risk capital for a firm should be less than the total of the individual risk capitals of the underlying business units. This is because the correlation of returns between business units is likely to be less than +1.

A business unit with earnings or cash flows that are highly correlated to the overall firm should be allocated more risk capital than a business unit with earnings or cash flows that are negatively correlated (assuming similar volatility). Having business lines that are countercyclical in nature allows the overall firm to have stable earnings and to attain a given desired credit rating using less risk capital.

LO 48.8

The management team needs to be actively involved with the implementation of a RAROC approach within the firm and promote it as a means of measuring shareholder value creation.

The RAROC process needs to be clearly explained to all levels of management of the firm in order to have sufficient "buy in" from management.

A committee consisting of members from the various business units as well as the risk management group should periodically review the metrics that impact economic capital calculations in order to promote fairness in the capital allocation process.

The RAROC team should be responsible for the data collection process, the computations, and the reporting. The business units and the accounting department should be responsible for putting controls in place to ensure the accuracy of the data being used for the RAROC calculations.

A qualitative assessment of each business unit could be performed using a four-quadrant analysis. The horizontal axis would represent the expected RAROC return and the vertical axis would represent the quality of the earnings based on the importance of the business unit's activities to the overall firm, growth opportunities, long-run stability and volatility of earnings, and any synergies with other business units.

Business units should submit their limit requests (e.g., economic capital, leverage, liquidity, risk-weighted assets) quarterly to the RAROC team. The RAROC team performs the relevant analysis and sets the limits in a collaborative manner that allows business units to express any objections.

Concept Checkers

1. Which of the following statements regarding the risk-adjusted return on capital (RAROC) methodology is correct?
   A. In the context of performance measurement, RAROC uses accounting profits.
   B. In the numerator of the RAROC equation, expected loss is added to the return.
   C. If a business unit's cost of equity is greater than its RAROC, then the business unit is not adding value to shareholders.
   D. RAROC is useful for determining incentive compensation but it lacks the flexibility to consider deferred or contingent compensation.

2. Assume the following information for a commercial loan portfolio:
   - $1.2 billion principal amount
   - 6% pre-tax expected return on loan portfolio
   - Direct annual operating costs of $8 million
   - Loan portfolio funded by $1.2 billion of retail deposits; interest rate = 4%
   - Expected loss on the portfolio is 0.4% of principal per annum
   - Unexpected loss of 7% of the principal amount
   - Risk-free rate on government securities is 1%
   - 30% effective tax rate
   - Assume no transfer pricing issues

   Based on the information provided, which of the following amounts is closest to the RAROC?
   A. 9.33%
   B. 10.03%.
   C. 12.33%.
   D. 14.66%.

3. Which of the following statements regarding the computation of economic capital is correct?
   I. Selecting a longer time horizon for RAROC calculations is preferable because risk and return data is more reliable with more time.
   II. Choosing a lower confidence level will not likely reduce the amount of risk capital required if the firm has little exposure to operational, credit, and settlement risks.
   A. I only.
   B. II only.
   C. Both I and II.
   D. Neither I nor II.

4 Which of the following statements regarding the choice of default probability approaches in computing economic capital is correct?
A. A through-the-cycle (TTC) approach should be used to price financial instruments with credit risk exposure.
B. A point-in-time (PIT) approach is more commonly used for computations involving profitability and strategic decisions.
C. A TTC approach is more likely to result in a lower volatility of capital compared to the PIT approach.
D. A firm's rating will not change when analyzed under the PIT approach versus the TTC approach.

5. Which of the following statements regarding best practices in implementing a RAROC approach is correct?
A. A successful RAROC approach is focused on maximizing profits earned by the firm.
B. A restriction on the firm's growth due to leverage limitations may result in higher profits.
C. The data collection process throughout the firm should be decentralized to allow the various business units to ensure the utmost accuracy of data.
D. Metrics involving credit risk, market risk, and operational risk to compute economic capital are generally clearly defined and may be computed objectively.

Concept Checker Answers

1. **C** The cost of equity represents the minimum rate of return on equity required by shareholders. Therefore, if RAROC is below the cost of equity, then there is no value being added.

   Response A is not correct because RAROC uses economic profits, not accounting profits. Response B is not correct because in the numerator of the RAROC equation, expected loss is deducted from the return. Response D is not correct because RAROC has the flexibility to consider deferred or contingent compensation.

2. **B** Unexpected loss ($1.2 billion × 7% = $84 million) is equal to the amount of economic capital required. The return on economic capital is then $84 million × 1% = $0.84 million. Also, expected revenues = 0.06 × $1.2 billion = $72 million; interest expense = 0.04 × $1.2 billion = $48 million; expected losses = 0.004 × $1.2 billion = $4.8 million.

$$\text{RAROC} = \frac{\begin{pmatrix}\text{expected revenues} - \text{costs} - \text{expected losses} \\ - \text{taxes} + \text{return on economic capital} \pm \text{transfers}\end{pmatrix}}{\text{economic capital}}$$

$$\text{RAROC} = \frac{(72 - 8 - 48 - 4.8 + 0.84 + 0) \times (1 - 0.3)}{84} = 10.03\%$$

3. **B** Choosing a lower confidence level will not likely reduce the amount of risk capital required if the firm has little exposure to operational, credit, and settlement risks. The reduction would be much more dramatic only if the firm has significant exposure to such risks because large losses would be rare.

   In selecting a time horizon for RAROC calculations, risk and return data for periods over one year is likely to be of questionable reliability.

4. **C** A firm's rating is more likely to change when analyzed under the point-in-time (PIT) approach compared to the through-the-cycle (TTC) approach. As a result, the TTC approach results in a lower volatility of economic capital compared to the PIT approach.

   A PIT approach should be used to price financial instruments with credit risk exposure and to compute short-term expected losses. A TTC approach is more commonly used for computations involving profitability, strategic decisions, and economic capital.

5. **B** A restriction on the firm's growth due to leverage limitations may result in higher profits because it requires the firm to be "creative" and to optimize a scarce resource (the limited amount of capital available).

   Response A is not correct. A successful RAROC approach is focused on the level of profits earned by the firm in relation to the level of risks taken. Response C is not correct. The data collection process should be the responsibility of the RAROC team; the process should be centralized with built-in edit and reasonability checks to increase the accuracy of the data. Response D is not correct. Metrics involving operational risk are not as defined as credit and market risk, therefore, there is often a significant amount of subjectivity involved in the computations.

The following is a review of the Operational and Integrated Risk Management principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

Range of Practices and Issues in Economic Capital Frameworks

Topic 49

Exam Focus

This topic requires an understanding of many risk management concepts that you have already covered at FRM Part I, as well as in earlier readings in the FRM Part II curriculum. Specifically, this topic expands on the concept of economic capital, which is the capital required to absorb unexpected losses for a given time horizon and confidence interval. For the exam, pay attention to the terminology and attempt to integrate this material to the sections pertaining to market risk and credit risk so as to reinforce your understanding.

Economic Capital Implementation Framework

LO 49.1: Within the economic capital implementation framework describe the challenges that appear in:
- **Defining and calculating risk measures**
- **Risk aggregation**
- **Validation of models**
- **Dependency modeling in credit risk**
- **Evaluating counterparty credit risk**
- **Assessing interest rate risk in the banking book**

For this LO, it would be helpful to recall the properties of a **coherent risk measure** from the Part I curriculum. The properties are as follows:

1. **Monotonicity:** A portfolio with greater future returns will likely have less risk.
2. **Subadditivity:** The risk of a portfolio is at most equal to the risk of the assets within the portfolio.
3. **Positive homogeneity:** The size of a portfolio will impact the size of its risk.
4. **Translation invariance:** The risk of a portfolio is dependent on the assets within the portfolio.

Defining and Calculating Risk Measures

It is not always apparent how risk should be quantified for a given bank, especially when there are many different possible risk measures to consider. Prior to defining specific measures, one should be aware of the general characteristics of ideal risk measures. They

should be: intuitive, stable, easy to compute, easy to understand, coherent, and interpretable in economic terms. In addition, the risk decomposition process must be simple and meaningful for a given risk measure.

Standard deviation, value at risk (VaR), expected shortfall (ES), as well as spectral (i.e., coherent) and distorted risk measures could be considered, each with their respective pros and cons. Obviously, no one measure would perfectly consider all of the necessary elements in measuring risk. In practice, VaR and ES are the most commonly used measures. The following section is a summary of challenges encountered when considering the appropriateness of each risk measure.

Standard deviation

- Not stable because it depends on assumptions about the loss distribution.
- Not coherent because it violates the monotonicity condition.
- Simple, but not very meaningful in the risk decomposition process.

VaR (the most commonly used measure)

- Not stable because it depends on assumptions about the loss distribution.
- Not coherent because it violates the subadditivity condition (could cause problems in internal capital allocation and limit setting for sub-portfolios).

Expected shortfall

- May or may not be stable, depending on the loss distribution.
- Not easy to interpret, and the link to the bank's desired target rating is not clear.

Spectral and distorted risk measures

- Not intuitive nor easily understood (and rarely used in practice).
- May or may not be stable, depending on the loss distribution.

In defining or using such risk measures, banks often consider several of them and for different purposes. For example, absolute risk and capital allocation within the bank are most commonly measured using VaR, but increasingly, the latter is being measured using ES. The VaR measure of absolute risk tends to be easier to communicate to senior management than ES, but ES is a more stable measure than VaR for allocating total portfolio capital. The challenge for the bank is to determine if and when one or the other, or both, should be used.

Amongst the commonly used measures to calculate economic capital, regulators do not have a clear preference for one over another. If different risk measures are implemented by a bank for external versus internal purposes, then there must be a logical connection between the two risk measures. For regulators, merely comparing a bank's internal and regulatory capital amounts is insufficient when determining the underlying risks in its portfolio. Therefore, such a task presents an analytical challenge to regulators.

Risk Aggregation

Risk aggregation involves identifying the individual risk types and making certain choices in aggregating those risk types. Classification by risk types (market, credit, operational, and business) may be approximate and prone to error. For example, the definitions of risk types may differ across banks or within a given bank, which complicates the aggregation process.

Even though one or more of the previously mentioned four risk types may be found at the same time within a given bank portfolio, the portfolio will often be represented by one risk type for the bank's classifications purposes. Such a simplistic distinction may result in inaccurate measurements of the risk types and this may bias the aggregation process.

Most banks begin by aggregating risk into silos by risk-type across the entire bank. Other banks prefer using business unit silos, while others combine both approaches. There is no one unanimously accepted method, as each approach has its specific advantages.

Before risk types can be aggregated into a single measure, they must be expressed in comparable units. There are three items to consider: risk metric, confidence level, and time horizon.

1. **Risk metric:** Relies on the metrics used in the quantification of different risk types. Must consider whether the metric satisfies the subadditivity condition.

2. **Confidence level:** Loss distributions for different types of risk are assumed to have different shapes, which implies differences in confidence intervals. The lack of consistency in choosing confidence levels creates additional complexity in the aggregation process.

3. **Time horizon:** Choosing the risk measurement time horizon is one of the most challenging tasks in risk measurement. For example, combining risk measures that have been determined using different time horizons creates problems irrespective of actual measurement methods used. Specifically, there will be inaccurate comparisons between risk types.

A common belief is that combining two portfolios will result in lower risk per investment unit in the combined portfolio versus the weighted average of the two separate portfolios. However, when we consider risk aggregations across different portfolios or business units, such a belief does not hold up with VaR because it does not necessarily satisfy the subadditivity condition. Also, there may be a false assumption that covariance always fully takes into account the dependencies between risks. Specifically, there could be times where the risk interactions are such that the resulting combinations represent higher, not lower, risk. These points highlight an additional challenge in the computation of risk.

There are five commonly used aggregation methodologies. The following is a brief description of them, as well as the challenges associated with using them.

1. Simple summation
    - Adding together individual capital components.

- Does not differentiate between risk types and therefore assumes equal weighting. Also, does not take into account the underlying interactions between risk types or for differences in the way the risk types may create diversification benefits. In addition, complications arising from using different confidence levels are ignored.

2. Constant diversification
   - Same process as simple summation except that it subtracts a fixed diversification percentage from the overall amount.
   - Similar challenges as simple summation.

3. Variance-covariance matrix
   - Summarizes the interdependencies across risk types and provides a flexible framework for recognizing diversification benefits.
   - Estimates of inter-risk correlations (a bank-specific characteristic) are difficult and costly to obtain, and the matrix does not adequately capture non-linearities and skewed distributions.

4. Copulas
   - Combines marginal probability distributions into a joint probability distribution through copula functions.
   - More demanding input requirements and parameterization is very difficult to validate. In addition, building a joint distribution is very difficult.

5. Full modeling/simulation
   - Simulate the impact of common risk drivers on all risk types and construct the joint distribution of losses.
   - The most demanding method in terms of required inputs. Also, there are high information technology demands, the process is time consuming, and it may provide a false sense of security.

The variance-covariance approach is commonly used by banks. Frequently, however, bank-specific data is not available or is of poor quality. As a result, the items in the variance-covariance matrix are completed on the basis of expert judgment. On a related note, banks often use a "conservative" variance-covariance matrix where the correlations are reported to be approximate and biased upward. In order to reduce the need for expert judgment, banks may end up limiting the dimensionality of the matrix and aggregating risk categories so that there are only a few of them, not recognizing that such aggregations embed correlation assumptions. Clearly, a disadvantage of such a practice is that each category becomes less homogenous and therefore, more challenging to quantify.

One potential disadvantage of the more sophisticated methodologies is that they often lead to greater confidence in the accuracy of the output. It is important to consider robustness checks and estimates of specification and measurement error so as to prevent misleading results.

Validation of Models

Validation is the "proof" that a model works as intended. As an example, while it is a useful tool to test a model's risk sensitivity, it is less useful for testing the accuracy of high quantiles in a loss distribution.

The validation of economic capital models differs from the valuation of an IRB (internal-ratings based) model because the output of economic capital models is a distribution rather than a single predicted forecast against which actual outcomes may be compared. Also, economic capital models are quite similar to VaR models despite the longer time horizons, higher confidence levels, and greater lack of data.

There are six *qualitative* validation processes to consider. The following is a brief description of them, as well as the challenges associated with using them (where applicable).

1. Use test
   - If a bank uses its measurement systems for internal purposes, then regulators could place more reliance on the outputs for regulatory capital.
   - The challenge is for regulators to obtain a detailed understanding of which model's properties are being used and which are not.

2. Qualitative review
   - Must examine documentation and development work, have discussions with the model's developers, test and derive algorithms, and compare with other practices and known information.
   - The challenge is to ensure that the model works in theory and takes into account the correct risk drivers. Also, confirmation of the accuracy of the mathematics behind the model is necessary.

3. Systems implementation
   - For example, user acceptance testing and checking of code should be done prior to implementation to ensure implementation of the model is done properly.

4. Management oversight
   - It is necessary to have involvement of senior management in examining the output data from the model and knowing how to use the data to make business decisions.
   - The challenge is ensuring that senior management is aware of how the model is used and how the model outputs are interpreted.

5. Data quality checks
   - Processes to ensure completeness, accuracy, and relevance of data used in the model. Examples include: qualitative review, identifying errors, and verification of transaction data.

6. Examination of assumptions—sensitivity testing
   - Assumptions include: correlations, recovery rates, and shape of tail distributions. The process involves reviewing the assumptions and examining the impact on model outputs.

There are also six *quantitative* validation processes to consider. The following is a brief description of them, as well as the challenges associated with using them (where applicable).

1. Validation of inputs and parameters
   - Validating input parameters for economic capital models requires validation of those parameters not included in the IRB approach, such as correlations.

- The challenge is that checking model inputs is not likely to be fully effective because every model is based on underlying assumptions. Therefore, the more complex the model, the more likely there will be model error. Simply examining input parameters will not prevent the problem.

2. Model replication
   - Attempts to replicate the model results obtained by the bank.
   - The challenge is that the process is rarely enough to validate models and in practice, there is little evidence of it being used by banks. Specifically, replication simply by re-running a set of algorithms to produce the same set of results is not considered enough model validation.

3. Benchmarking and hypothetical portfolio testing
   - The process is commonly used and involves determining whether the model produces results comparable to a standard model or comparing models on a set of reference portfolios.
   - The challenge is that the process can only compare one model against another and may provide little comfort that the model reflects "reality." All that the process is able to do is provide broad comparisons confirming that input parameters or model outputs are broadly comparable.

4. Backtesting
   - Considers how well the model forecasts the distribution of outcomes—comparison of outcomes to forecasts.
   - The challenge is that the process can really only be used for models whose outputs can be characterized by a quantifiable metric with which to compare an outcome. Obviously, there will be risk measurement systems whose outputs cannot be interpreted this way. Also, backtesting is not yet a major part of banks' validation practices for economic purposes.

5. Profit and loss attribution
   - Involves regular analysis of profit and loss—comparison between causes of actual profit and loss versus the model's risk drivers.
   - The challenge is that the process is not widely used except for market risk pricing models.

6. Stress testing
   - Involves stressing the model and comparing model outputs to stress losses.

Overall, although these validation processes may be highly effective in areas such as risk sensitivity, they may not be effective in areas such as overall absolute accuracy.

Additionally, there is difficulty in validating the conceptual soundness of a capital model. The development of a model almost always requires assumptions to be made. However, some of the assumptions may not be testable, so it could be impossible to be absolutely certain of the conceptual soundness of a model. Even though the underlying points may appear reasonable and logical, that may not be the case in practice.

From a regulator's perspective, some industry validation practices are weak, especially for total capital adequacy of the bank and the overall calibration of models. Such a

validation project is challenging because it usually requires evaluation of high quantiles of loss distributions over long periods of time. In addition, there are data scarcity problems plus technical difficulties, such as tail estimation. Therefore, it is important for senior management and model users to understand the limitations of models and the risks of using models that have not been fully validated.

Dependency Modeling in Credit Risk

Modeling the dependency structure between borrowers is crucial, yet challenging. Both linear and nonlinear dependency relationships between obligors need to be considered.

In general, dependencies can be modeled using: credit risk portfolio models, models using copulas, and models based on the asymptotic single-risk factor (ASRF) model. With the ASRF approach, banks may use their own estimates of correlations or may use multiple systematic risk factors to address concentrations. Such an approach would result in questioning the method used to calibrate the correlations and the ways in which the bank addressed the infinite granularity and single-factor structure of the ASRF model. ASRF can be used to compute the capital requirement for credit risk under the IRB framework.

There are many issues to consider regarding the challenges in coming up with reliable dependency assumptions used in credit risk portfolio models. Regulators may need to test the accuracy and strength of correlation estimates used by banks given their heavy reliance on model assumptions and the significant impact on economic capital calculations.

In the past, the validity of the following assumptions have been questioned: (1) the ASRF Gaussian copula approach, (2) the normal distribution for the variables driving default, (3) the stability of correlations over time, and (4) the joint assumptions of correctly specified default probabilities and doubly-stochastic processes, which suggest that default correlation is sufficiently captured by common risk factors.

Doubts have been raised about the ability of some models using such assumptions in terms of their ability to explain the time-clustering of defaults that is seen in certain markets. Insufficiently integrating the correlation between probability of default (PD) and loss given default (LGD) in the models, coupled with insufficiently modeling LGD variability, may lead to underestimating the necessary economic capital. Furthermore, it will create challenges in identifying the different sources of correlations and the clustering of defaults and losses.

Rating changes are greatly impacted by the business cycle and are explained by different models during expansionary and recessionary periods. As a result, the sample period and approach used to calibrate the dependency structure could be important in assessing whether correlation estimates are overestimated or underestimated. Furthermore, some models assume that unobservable asset returns may be approximated by changes in equity prices but fail to consider that the relationship between asset returns and equity prices are unobservable and may be non-linear. Also, the use of equity prices to estimate credit default probability is problematic because such prices may include information that is irrelevant for credit risk purposes. As a result, using equity prices may result in some inaccuracy in the correlation estimates.

In contrast, when banks use a regulatory-type approach, the assumptions of such an approach create other challenges for both banks and regulators:

- Correlation estimates need to be estimated, but there may be limited historical data on which to base the correlation estimates. Also, the assumptions used to generate the correlations may not be consistent with the underlying assumptions of the Basel II credit risk model.
- A bank's use of the Basel II risk weight model requires concentration risk to be accounted for by other measures and/or management methods. It will also require regulators to evaluate such measures/methods.

A key challenge to overcome is the use of misspecified or incorrectly calibrated correlations and the use of a normal distribution (which does not replicate the details of the distribution of asset returns). This may lead to large errors in measuring portfolio credit risk and economic capital.

Evaluating Counterparty Credit Risk

Such a task is a significant challenge because it requires: obtaining data from multiple systems, measuring exposures from an enormous number of transactions (including many that exhibit optionality) spanning a wide range of time periods, monitoring collateral and netting arrangements, and categorizing exposures across many counterparties. As a result, banks need to have well-developed processes and trained staff to deal with these challenges.

Market-risk-related challenges to counterparty exposure at default (EAD) estimation.

- Counterparty credit exposure requires simulation of market risk factors and the revaluation of counterparty positions under simulated risk factor shocks, similar to VaR models. Consider the following two challenges that occur when attempting to use VaR model technology to measure counterparty credit exposure.
    - Market risk VaR models combine all positions in a portfolio into a single simulation. Therefore, gains from one position may fully offset the losses in another position in the same simulation run. However, counterparty credit risk exposure measurement does not allow netting across counterparties. As a result, it is necessary to compute amounts at the netting set level (on each set of transactions that form the basis of a legally enforceable netting agreement), which increases computational complexity.
    - Market risk VaR calculations are usually performed for a single short-term holding period. However, counterparty credit exposure measurement must be performed for multiple holding periods into the future. Therefore, market risk factors need to be simulated over much longer time periods than in VaR calculations, and the revaluation of the potential exposure in the future must be done for the entire portfolio at certain points in the future.

Credit-risk-related challenges to PD and LGD estimation.

- Some material transactions are performed with counterparties with which the bank does not have any other exposures. Therefore, the bank must calculate a probability of default (PD) and loss given default (LGD) for the counterparty and transaction.
- For hedge funds, the measurement challenge occurs when there is little information provided on underlying fund volatility, leverage, or types of investment strategies employed.
- Even for counterparties with which the bank has other credit exposures, the bank still needs to calculate a specific LGD for the transaction.

Interaction between market risk and credit risk—wrong-way risk.

- Identifying and accounting for wrong-way risk (exposures that are negatively correlated with the counterparty's credit quality) is a significant challenge because it requires an understanding of the market risk factors to which the counterparty is exposed. That would be difficult to do in the case of a hedge fund, for example, which would be less transparent.
- It also requires a comparison of those factor sensitivities to the factor sensitivities of the bank's own exposures to the counterparty.
- The magnitude of wrong-way risk is difficult to quantify in an economic capital model since it requires a long time horizon at a high confidence level.

Operational-risk-related challenges in managing counterparty credit risk.

- The challenge is that managing such risk requires specialized computer systems and people. Complicated transactions, such as daily limit monitoring, marking-to-market, collateral management, and intraday liquidity and credit extensions, increase the risk of measurement errors.
- The quantification of operational risks is a significant challenge, especially when it pertains to new or rapidly growing businesses, new products or processes, intraday extensions of credit, and infrequently occurring but severe events.

Differences in risk profiles between margined and non-margined counterparties.

- The modeling difference between the two types of counterparties is primarily concerned with the future forecasting period. For margined counterparties, the forecasting period is short, and for non-margined counterparties, it is usually much longer.
- As a result of the difference in time periods, the aggregation of risk between these two types of counterparties is a challenge because the usual procedure is to use a single time period for all positions.

Aggregation challenges.

- In general, the challenges are increased significantly when moving from measuring credit risk of one counterparty to measuring credit risk of the firm in general for economic capital purposes.
- When counterparties have both derivatives and securities financing activities, the problem is especially challenging because the systems in place may not be able to handle such aggregation.
- Further aggregation challenges exist when high-level credit risk measures are required to be aggregated with high-level market risk and operational risk measures in order to calculate economic capital.
- Breaking down counterparty credit risk into detailed component parts (as is often done with market risk) is another challenge. The sheer computational complexities and enormous amounts of data required would generally be cost prohibitive to perform on a frequent basis. The challenge still remains for many banks due to outdated or ineffective computer systems.

Assessing Interest Rate Risk in the Banking Book

The computation challenge arises from the long holding period assumed for a bank's balance sheet and the need to model indeterminate cash flows on both the asset and liability side due to the embedded optionality of many banking book items.

Optionality in the banking book.

- A major measurement challenge is found with non-linear risk from long-term fixed-income obligations with embedded options for the borrower to prepay and from embedded options in non-maturity deposits.
- In considering the asset side of the balance sheet, prepayment risk options (i.e., mortgages, mortgage-backed securities, and consumer loans) are the main form of embedded options. The prepayment option results in uncertain cash flows and makes interest rate risk measurement a difficult task.
- In considering the liability side, there are two embedded options in non-maturity deposits: (1) the bank has an option to determine the interest rate paid to depositors and when to amend the rate, and (2) the depositor has the option to withdraw up to the entire balance with no penalty. The interaction between these two embedded options creates significant valuation and interest rate sensitivity measurement problems.
- Sufficiently modeling optionality exposures requires very complex stochastic-path evaluation techniques.

Banks' pricing behavior.

- This factor contributes to the challenges in measuring the interest rate risk of banking book items. For example, it would require a model to analyze the persistence of the many different non-maturity banking products, as well as a model to determine bank interest rates that consider general market conditions, customer relationships, bank commercial power, and optimal commercial policies.
- Determining bank interest rates would require the pricing of credit risk. The price of credit risk applied to different banking products creates a challenge because it would require a pricing rule that links the credit spread to changes in macroeconomic conditions and interest rate changes. Also, it means that interest rate stress scenarios should consider the dependence between interest rate and credit risk factors.

The choice of stress scenarios.

- The drawbacks of using simple interest rate shocks pose interest rate measurement challenges because the shocks:
  - Are not based on probabilities and, therefore, are difficult to integrate into economic capital models based on VaR.
  - Are not necessarily sensitive to the current rate or economic environment.
  - Do not take into account changes in the slope or curvature of the yield curve.
  - Do not allow for an integrated analysis of interest rate and credit risks on banking book items.

BIS Recommendations for Supervisors

LO 49.2: Describe the BIS recommendations that supervisors should consider to make effective use of internal risk measures, such as economic capital, that are not designed for regulatory purposes.

There are ten Bank for International Settlements (BIS) recommendations to consider:

1. **Use of economic capital models in assessing capital adequacy.** The bank should show how such models are used in the corporate decision-making process so as to assess the model's impact on which risks the bank chooses to accept. In addition, the board should have a basic understanding of the difference between gross (stand alone) and net (diversified) enterprise-wide risk in assessing the bank's net risk tolerance.

2. **Senior management.** The economic capital processes absolutely require a significant commitment from senior management. They should understand its importance in the corporate planning process and should ensure that there is a strong infrastructure in place to support the processes.

3. **Transparency and integration into decision-making.** Economic capital results need to be easy to trace and understand in order to be useful. Careful attention must be given to obtaining reliable estimates on an absolute basis in addition to developing the flexibility to conduct firm-wide stress testing.

4. **Risk identification.** This is the crucial starting point in risk measurement. The risk measurement process must be very thorough to ensure that the proper risk drivers, positions, and exposures are taken into account in measuring economic capital. That will ensure that there is little variance between inherent (actual) and measured risk. For example, risks that are difficult to quantify should be considered through sensitivity analysis, stress testing, or scenario analysis.

5. **Risk measures.** No given risk measure is perfect, and a bank must understand the strengths and weaknesses of its chosen risk measures. No one risk measure for economic capital is universally preferred.

6. **Risk aggregation.** The reliability of the aggregation process is determined by the quality of the measurement risk components, plus the interrelationships between such risks. The aggregation process usually requires consistency in the risk measurement parameters. The aggregation methodologies used should mirror the bank's business composition and risk profile.

7. **Validation.** The validation process for economic capital models must be thorough and corroborating evidence from various tests must show that the model "works" as intended. In other words, within an agreed upon confidence interval and time period, the capital level determined must be enough to absorb the (unexpected) losses.

8. **Dependency modeling in credit risk.** Banks must consider the appropriateness of the dependency structures used within their credit portfolio. Specifically, credit models need to be assessed for their limitations, and such limitations need to be dealt with via appropriate supplementary risk management approaches, such as sensitivity or scenario analysis.

9. **Counterparty credit risk.** There are trade-offs to be considered in deciding between the available methods of measuring counterparty credit risk. Additional methods, such as stress testing need to be used to help cover all exposures. Measuring such risk is complicated and challenging. Specifically, the aggregation process needs to be vetted prior to a bank having a big picture perspective of counterparty credit risk.

10. **Interest rate risk in the banking book.** Specifically, financial instruments with embedded options need to be examined closely in order to control risk levels. Certainly, there are trade-offs between using earnings-based versus economic value-based models to measuring interest rate risk. For example, the former has aggregation problems because other risks are measured using economic value. Also, using economic value-based models could be inconsistent with business practices.

Economic Capital Constraints and Opportunities

LO 49.3: Explain benefits and impacts of using an economic capital framework within the following areas:
- **Credit portfolio management**
- **Risk based pricing**
- **Customer profitability analysis**
- **Management incentives**

Credit Portfolio Management

Constraints imposed:

- Credit quality of each borrower is determined in a portfolio context, not on a stand-alone basis.
- A loan's incremental risk contribution is used to determine the concentration of the loan portfolio.

Opportunities offered:

- The process allows one to determine appropriate hedging strategies to use in reducing portfolio concentration.
- Credit portfolio management becomes a means for protecting against risk deterioration.

Risk-Based Pricing

Constraints imposed:

- Pricing decisions are based on expected risk-adjusted return on capital (RAROC), so deals will be rejected if they are lower than a specific RAROC. The proposed interest rate is determined by the amount of economic capital allocated to the deal.

- Pricing decisions include: (1) cost of funding, (2) expected loss, (3) allocated economic capital, and (4) additional return required by shareholders. Therefore, a minimum interest rate is determined that will increase shareholder value.

Opportunities offered:

- Can be used to maximize the bank's profitability. For example, some pricing decisions may need to be overridden because certain customer relationships are more profitable (at a lower price/interest rate) or desirable from a reputational point of view. Of course, such overrides are not taken lightly and require upper management approval, as well as rigorous subsequent monitoring.

Customer Profitability Analysis

Constraints imposed:

- The analysis is complicated in that many risks need to be aggregated at the customer level.
- Customers need to be segmented in terms of ranges of (net) return per unit of risk; the underlying information is difficult to measure and allocate.

Opportunities offered:

- Assuming that the measurement obstacles have been overcome, the analysis can be easily used to determine unprofitable or only slightly profitable customers. Such customers could be dropped and economic capital allocated to the more profitable customers.
- Economic capital is used in maximizing the risk-return trade-off (through relative risk-adjusted profitability analysis of customers).

Management Incentives

Constraints imposed:

- Studies show that compensation schemes are a minor consideration in terms of the actual uses of economic capital measures at the business unit level.

Opportunities offered:

- It is suggested that management incentives is the issue that motivates bank managers to participate in the technical aspects of the economic capital allocation process.

Best Practices and Concerns for Economic Capital Governance

LO 49.4: Describe best practices and assess key concerns for the governance of an economic capital framework.

The soundness of economic capital measures relies on strong controls and governance. Senior management is responsible for making sure these controls are in place and that governance covers the entire economic capital process. Adopting an economic capital framework will improve a bank's capital adequacy, strategic planning, risk appetite documentation, and risk-adjusted performance measurement. In order for an economic capital framework to be effective it should include:

- Strong controls for changing risk measurements.
- Comprehensive documentation for measuring risk and allocation approaches.

- Policies for making sure economic capital practices follow outlined procedures.
- View of how economic capital measures apply to daily business decisions.

Best practices for the governance of an economic capital framework cover:

1. *Senior management commitment*. The successful implementation of an economic capital framework depends on the involvement and experience of the senior management group. They are one of the main drivers for adopting this framework.

2. *The business unit involved and its level of expertise.* Governance structures differ among banks. Some banks opt for a centralized approach where economic capital responsibilities are assigned to one function (e.g., Treasury), while others opt for a decentralized approach that shares responsibilities between functions (e.g., finance and risk functions). Each business unit within the bank will manage its risk in accordance with the amount of allocated capital. The responsibilities for allocating capital within business units will also vary among banks as will the flexibility to reallocate capital during the budgeting period.

3. *The timing of economic capital measurement and disclosures.* Most banks will compute economic capital on either a monthly or quarterly basis. Pillar 3 of the Basel II Accord encourages the disclosure of information about how capital is allocated to risks.

4. *Policies and procedures for owning, developing, validating, and monitoring economic capital models.* Formal policies and procedures encourage the consistent application of economic capital across the bank. The owner of the economic capital model will usually oversee the economic capital framework.

Key concerns related to governance and the application of economic capital measures involve:

1. *Senior management commitment.* The level of management buy-in contributes to the meaningfulness of the economic capital process. The senior management group must understand the importance of applying economic capital measures for strategic planning purposes.

2. *The role of stress testing.* Many banks currently apply stress tests; however, using more integrating stress tests will allow banks to better assess the impact of a stress scenario on certain economic capital measures.

3. *Measuring risk on either an absolute or relative basis.* Correctly interpreting economic capital as an estimate of risk depends on either measuring the absolute level of capital or measuring risk on a relative basis. Some issues within this measurement concern include assumptions regarding diversification and management involvement as well as how the economic model captures risks.

4. *Not using economic capital as the only measure that determines required capital.* Most banks align economic capital with external credit ratings. Shareholders desire profitability via lower capital levels while rating agencies encourage solvency via higher capital levels.

5. *Defining available capital resources.* Currently, there is no definition for available capital among banks. Most banks adjust Tier 1 capital to determine available capital resources.

6. *Transparency of economic capital measures.* Economic capital models are more useful for senior managers when they are transparent. Increased documentation will improve the validity of using the model when making business decisions.

Key Concepts

LO 49.1

A multitude of challenges exist within the economic capital framework that involve: (1) defining risk measures, (2) risk aggregation, (3) validation of models, (4) dependency modeling in credit risk, (5) evaluating counterparty credit risk, and (6) assessing interest rate risk in the banking book.

LO 49.2

There are ten BIS recommendations that supervisors should consider to make effective use of risk measures.

LO 49.3

A number of specific constraints imposed and opportunities offered by economic capital exist within the areas of credit portfolio management, risk based pricing, customer profitability analysis, and management incentives.

LO 49.4

Best practices for the governance of an economic capital framework cover: (1) senior management commitment, (2) the business unit involved and its level of expertise, (3) the timing of economic capital measurement and disclosures, and (4) policies and procedures for owning, developing, validating, and monitoring economic capital models.

Key concerns related to governance and the application of economic capital measures involve: (1) senior management commitment, (2) the role of stress testing, (3) measuring risk on either an absolute or relative basis, (4) not using economic capital as the only measure that determines required capital, (5) defining available capital resources, and (6) transparency of economic capital measures.

Concept Checkers

1. Which of the following risk measures is the least commonly used measure in the practice of risk management?
   A. Value at risk.
   B. Standard deviation.
   C. Expected shortfall.
   D. Spectral risk measures.

2. Which of the following aggregation methodologies is characterized by great difficulty in validating parameterization and building a joint distribution?
   A. Copulas.
   B. Constant diversification.
   C. Variance-covariance matrix.
   D. Full modeling/simulation.

3. Which of the following model validation processes is specifically characterized by the limitation that it provides little comfort that the model actually reflects reality?
   A. Backtesting.
   B. Benchmarking.
   C. Stress testing.
   D. Qualitative review.

4. Which of the following categories of BIS recommendations specifically refers to the need to consider using additional methods, such as stress testing, to help cover all exposures?
   A. Risk aggregation.
   B. Counterparty credit risk.
   C. Dependency modeling in credit risk.
   D. Interest rate risk in the banking book.

5. The use of which of the following items is meant more for protecting against risk deterioration?
   A. Risk based pricing.
   B. Management incentives.
   C. Credit portfolio management.
   D. Customer profitability analysis.

Concept Checker Answers

1. **D** Spectral and distorted risk measures are the least used of the four measures and are mainly of academic interest only.

2. **A** Copulas have two notable disadvantages: (1) parameterization is very difficult to validate, and (2) building a joint distribution is very difficult.

3. **B** With benchmarking and hypothetical portfolio testing, the process has its limitations because it can only compare one model against another and may provide little comfort that the model actually reflects "reality." All that the process is able to do is provide broad comparisons confirming that input parameters or model outputs are broadly comparable.

4. **B** There are trade-offs to be considered when deciding between the available methods of measuring counterparty credit risk. Additional methods, such as stress testing, need to be used to help cover all exposures.

5. **C** Credit portfolio management is used as a means to protect against risk deterioration. In contrast, risk based pricing is used to maximize the bank's profitability; customer profitability analysis is used to determine unprofitable or only slightly profitable customers; and management incentives are used to motivate managers to participate in the technical aspects of the economic capital allocation process.

The following is a review of the Operational and Integrated Risk Management principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

Capital Planning at Large Bank Holding Companies: Supervisory Expectations and Range of Current Practice

Topic 50

Exam Focus

To protect the smooth functioning of bank holding companies (BHCs), the Federal Reserve's Capital Plan Rule requires BHCs to implement an ongoing internal capital plan for thoroughly assessing and enhancing their capital adequacy under stress scenarios on a firm-wide basis. For the exam, know the fundamental principles and key practices to develop and implement an effective internal control plan, including: risk identifications, model valuation and review, oversight and governance, contingency planning, stress testing and scenario designing, loss estimation and projections methodologies, and evaluating the impact of capital adequacy, including risk-weighted assets and balance sheet projections.

Capital Plan Rule

LO 50.1: Describe the Federal Reserve's Capital Plan Rule and explain the seven principles of an effective capital adequacy process for bank holding companies (BHCs) subject to the Capital Plan Rule.

Bank holding companies (BHCs) must have adequate and sufficient capital for their survival and growth. Capital provides a cushion against unexpected losses and allows BHCs to continue to operate. The failure of BHCs (i.e., liabilities exceed assets, resulting in negative capital) would most likely be a burden on taxpayers and deposit insurance funds. An effective and sound capital management policy is critical for the health of BHCs, as well as the smooth functioning and stability of the entire financial system.

The Federal Reserve maintains its interest in survivability and smooth functioning BHCs through its **Capital Plan Rule** and the annual Comprehensive Capital Analysis and Review (CCAR). The CCAR is the Federal Reserve's supervisory program for evaluating capital plans.

The Capital Plan Rule mandates that BHCs develop and put in place a capital plan and a process to evaluate and monitor their capital adequacy. The capital plan covers all U.S. domiciled BHCs with total consolidated assets equal to $50 billion or more.

The Capital Plan Rule lists the principles that the Federal Reserve uses to evaluate the adequacy and appropriateness of a BHC's internal capital planning processes and practices.

The principles on which the Federal Reserve assesses BHCs for managing and allocating their capital resources is referred to as the **capital adequacy process** (CAP). The seven principles of the CAP are as follows:

1. **Risk management foundation**. A BHC has an effective capital risk management plan to encompass all key risk exposures on a firm-wide basis in terms of identification, evaluation, measurement, and control.

2. **Resource estimation methods**. A BHC has a capital resource estimation plan to clearly define and estimate available capital resources over a stress scenario time horizon.

3. **Loss estimation methods**. A BHC has a process for estimating potential losses and aggregating them on a firm-wide basis over a given stress scenario time horizon.

4. **Impact on capital adequacy**. A BHC has a process to evaluate the combined impact on capital adequacy—given loss estimates and capital resources combined—in light of the stated goals with respect to capital level and composition.

5. **Capital planning policy**. A BHC has a sound capital policy to develop capital goals, determine appropriate capital levels and composition as well as capital distributions (actions) and contingency plans.

6. **Internal controls.** A BHC has a vigorous internal controls policy in place for independent review, model validation, documentation, and internal audit of the capital adequacy process.

7. **Effective oversight**. A BHC has a board and senior management responsible for an effective and thorough oversight of multiple dimensions of the internal capital risk plan, including methods, processes, assessments, validations, reviews, documentation, infrastructure, resources, goals, limitations, and approval of capital decisions.

Capital Adequacy Process

LO 50.2: Describe practices that can result in a strong and effective capital adequacy process for a BHC in the following areas:

- **Risk identification**
- **Internal controls, including model review and valuation**
- **Corporate governance**
- **Capital policy, including setting of goals and targets and contingency planning**
- **Stress testing and stress scenario design**
- **Estimating losses, revenues, and expenses, including quantitative and qualitative methodologies**
- **Assessing the impact of capital adequacy, including risk-weighted asset (RWA) and balance sheet projections**

For this LO, we detail the seven key practices that can result in a strong and effective capital adequacy process for a BHC.

Risk Identification

BHCs should have a process in place to identify all risk exposures stemming from numerous sources, including stress conditions, changing economic and financial environments, on-and-off balance sheet items, and their impact on capital adequacy. In addition, BHCs should critically scrutinize underlying assumptions regarding risk reduction through risk mitigation or risk transfer techniques. Senior management should regularly update and review the risk identification plan with special consideration for how their risk profiles might change under stress scenarios. Risk identification techniques should be able to detect the changes in the overall risk profile as well as the signs of capital inadequacy in the early stages.

BHCs should integrate the identified risk exposures into their internal capital planning processes. Scenario-based stress testing may not capture all potential risks faced by BHCs, some risks are difficult to quantify or they do not fall into the integrated firm-wide scenarios. However, such risks must be included and accounted for in the capital planning processes. These risks are categorized as "other risks," and their examples include compliance, reputational, and strategic risks. There are a variety of methods which BHCs can employ, including internal capital targets to incorporate such risks.

Internal Controls

An internal audit team should carefully scrutinize the internal control data for accuracy before submitting to senior management and the board. BHCs should have efficiently running management information systems (MIS) for collecting and analyzing pertinent information set quickly and accurately.

In addition, BHCs should put in place a detailed and organized documentation system fully encompassing all dimensions of capital planning processes, including risk identification, loss estimation techniques, capital adequacy, and capital decision processes.

There must be a thorough, independent, and regular review and validation of all models used for internal capital planning purposes, including assessment of conceptual soundness of models and verification of processes. A validation team should have a required technical skill set as well as complete independence from all business areas of the BHC and model developers. Such independence is crucial for the validation team to offer an unbiased, independent, and valuable verdict.

BHCs should maintain and update a list of all inputs, assumptions, and adjustments for the models used to generate final projections and estimates, such as income, loss expenses, and capital. These models should be validated for their effective use, not only under normal conditions, but also under stress conditions. BHCs should make full disclosure of their validation process and outcome, and should restrict the use of models which are not validated.

Governance

BHCs should have boards with sufficient expertise and involvement to fully understand and evaluate the information provided to them by senior management regarding their capital planning processes. The board should be furnished with comprehensive information with respect to risk exposures, loss estimates, determinants of revenues and losses, underlying models and assumptions, and weaknesses and strengths of capital planning processes. Also, the boards should be informed about the stress scenarios and any corrective measures undertaken as a result of stress testing outcomes.

Under the Capital Plan Rule, the management of BHCs is required to furnish key information to the board for its approval of internal capital adequacy plans. Such information should include underlying assumptions and results of stress testing and the outcome of internal audits, as well as model review and validation checks.

Senior management should evaluate the internal capital plan on an ongoing basis, focusing on key weaknesses, strengths, assumptions, scenarios, estimates, and models. In addition, senior management should make appropriate adjustments and remediation to the capital plan if the review process reveals shortcomings in the plan.

BHCs should maintain detailed minutes of board meetings, describing the issues raised and discussed, as well as the information used and the recommendations made in these meetings.

Capital Policy

A capital policy should clearly define the principles and guidelines for capital goals, issuance, usage, and distributions. The policy should also fully spell out the details of the BHC's capital planning processes, including the decision rules of capital usage and distribution, financing, and other policies. The capital policy should focus on the unique needs and financial situation of BHCs while taking into consideration the supervisory

expectations. Policies regarding common stock dividends and repurchase agreements should include the following:

- Key metrics influencing the size, timing, and form of capital distributions.
- Materials used in making capital distribution decisions.
- Specific scenarios that would cause a distribution to be reduced or suspended.
- Situations that would cause the BHC to consider replacing common equity with other forms of capital.
- Key roles and responsibilities of individuals or groups for producing reference materials, making distribution recommendations and decisions, and reviewing analysis.

Capital goals developed by BHCs should be compatible with their risk tolerance, risk profile, regulatory requirements, and expectations of various stakeholders (e.g., shareholders, creditors, supervisors, and rating agencies). BHCs should establish specific goals for both the level and composition of capital under normal as well as stress conditions. Capital targets, which need to be set above the capital goals for capital adequacy under stress conditions, should take into consideration future economic outlooks, stress scenarios, and market conditions.

While setting capital distribution levels, BHCs must take into consideration numerous factors, including future growth plans (including acquisitions) and associated risk, current and future general economic conditions, in particular the impact of macroeconomic and global events during stress conditions, on their capital adequacy. Capital distribution decisions must be connected to capital goals or capital adequacy requirements.

BHCs should develop strong contingency planning offering numerous options to deal with contingency situations as well as their effectiveness under stress conditions. Contingency plans should be based on realistic assumptions and contain futuristic outlooks, rather than overly relying on history. Contingency actions should be feasible and realistic in the sense that they should be easy to implement when or if the contingency warrants. Capital triggers flagging the early warning of capital deterioration should be based on the projected results, regulatory requirements, and the expectations of various stakeholders, including creditors, shareholders, regulators, investors, and counterparties.

Stress Testing and Stress Scenario Design

Scenario design and stress testing should focus on unique situations of BHCs, their asset and liability mix, portfolio composition, business lines, geographical territory, and revenue and loss factors, while taking into consideration the impact of macroeconomic and firm-specific vulnerabilities and risks. That is, the stress test designing should go above and beyond the general guidelines established by the supervisory authority. Also, a BHC's scenario designing and testing should not employ optimistic assumptions benefiting the BHC.

BHCs should employ both an internal model and expert judgment, an outside expert's opinion. If only a third-party model is used, it must be tailored to the unique risk profile and business model of a BHC. The designed scenarios should assume a strong strain on the revenue and income of BHCs.

Stress testing models should be based on multiple variables encompassing all the risk exposures faced by BHCs on a firm-wide basis. For example, BHCs concentrated in a region, business, or industry should include relevant region, business, or industry-related variables. In addition, the scenarios should clearly spell out how they address specific risks faced by BHCs. The description should also provide explanations of how a scenario stresses specific BHC weaknesses and how variables are related to each other.

Estimating Losses, Revenues, and Expenses

Quantitative and Qualitative Basis

BHCs should prefer using internal data to estimate losses, revenues, and expenses. However, in certain situations, it may be more appropriate to use external data. In these instances, it should be ensured that the external data reflects the underlying risk profile of their business lines, and necessary adjustments should be made to data input or output to make the analysis reflect a true picture of the BHC's unique characteristics.

A range of quantitative methods are available to BHCs for estimating losses, revenues, and expenses. Regardless of which method they use, the final outcome should be identification of key risk factors and impact of changing macro and financial conditions under normal and stress conditions on a firm-wide basis.

In addition, BHCs should segment their line of businesses and portfolios utilizing common risk characteristics showing marked differences in past performances. For example, a borrower's risk characteristics can be segmented by criteria such as credit score ranges. However, each risk segment should have sufficient data observations on losses, revenues, and expenses, (and underlying factors impacting losses, revenues, and expenses) in order to generate meaningful model estimates.

Past relationships between losses, revenues, expenses, and underlying driving factors, and their interrelationships may not hold in the future, thus, necessitating employment of sensitivity analysis (to answer "what if" questions) when using models based on historical underlying interactions.

BHCs sometimes use qualitative methodologies, like expert judgment or management overlay, as a substitute or a complement to quantitative methods. Qualitative techniques should be based on sound assumptions, and an external reviewer should find these approaches logical, reasonable, and clearly spelled out. A sensitivity analysis should be used for a qualitative approach as well. From a supervisory standpoint, BHCs are expected to use conservative assumptions, not favorable to BHCs, for estimating losses, revenues, and expenses under normal and stress conditions.

Loss Estimation Methods

BHCs should employ loss estimation methods, which offer theoretical soundness and empirical validity. In addition to using general macroeconomic explanatory variables, the loss estimation models should use specific variables exhibiting a direct link to particular exposures and portfolios.

BHCs should use uniform, reputable methods to aggregate losses across various lines of business and portfolios for firm-wide scenario analysis. They should also use automated processes, without manual intervention or managerial adjustments showing clear linkage from data sources to loss estimation and aggregation. For estimating retail loan losses, BHCs often use internal data, but for wholesale loss estimation, internal data is supplemented with external data. In the case using external data, BHCs should demonstrate that the data reflects their risk exposures, encompassing geographic, industry, and other key dimensions. Risk segmentation should be supported by the data capturing the unique characteristics of each risk pool.

BHCs can use either an economic loss approach (i.e., expected losses) or an accounting-based loss approach (i.e., charge-off and recovery) to estimate credit losses. For the expected loss approach, BHCs should categorize losses into probability of default (PD), loss given default (LGD), or exposure at default (EAD) and then identify the determinants of each component. Long run averages for PDs, LGDs, and EADs should not be used, as these averages reflect economic downturn and upturn periods not necessarily suitable for scenario testing under stress conditions. LGD should be linked to underlying risk factors, such as a fall in the value of collateralized assets under stress conditions, and it should be estimated at some level of segmentation, such as lending product or type of collateral. EADs should be modeled to exhibit variation depending on changes in macroeconomic conditions.

If BHCs are using rating systems as a key input to estimate expected losses under stress (e.g., on their wholesale portfolios), they should recognize the limitations in rating systems and their data and make necessary adjustments.

BHCs should utilize a robust time series with sufficient granularity while employing role-rate models to estimate the rate at which delinquent and non-delinquent accounts in the current quarter are expected to roll over into default or delinquent status in the next quarter.

If using charge-off models (i.e., accounting models), BHCs should include variables which represent the risk characteristics of an underlying portfolio while estimating the statistical relationship between charge-off rates and macroeconomic variables at the portfolio level.

Operational Risk

In order to determine operational risk, many BHCs estimate correlation between operational risk and macroeconomic factors. If they do not discover a statistically significant relationship between the variables, they employ other methods, including scenario analysis utilizing historical data and management input. BHCs should employ a combination of techniques to develop strong loss estimates under stress conditions, including past loss records, future expected events, macro conditions, and firm-specific risks.

BHCs using regression models to estimate loss frequency and loss severity under stress scenarios should provide statistical support for the period chosen for estimation purposes instead of arbitrary and judgmental selection.

A modified loss distribution approach (LDA) is also used by BHCs to estimate value at risk (VaR) to estimate operational risk losses at a chosen confidence interval (e.g., 90% or 95%).

To generate a strong and effective process, BHCs should offer a sound justification for their choice and perform a sensitivity analysis around the chosen interval.

Some BHCs use scenario analyses in case they encounter model or data limitations in order to incorporate a wide range of risks (which is not possible otherwise due to data or model limitations). In such events, BHCs should provide a rationale for the chosen scenario in their loss estimation process.

Market Risk and Counterparty Credit Risk

BHCs, which are involved in trading, are subject to counterparty credit risk from changes in the value of risk exposure and creditworthiness of the counterparty due to changing macroeconomic conditions.

In order to estimate the potential loss resulting from market credit interaction, BHCs use probabilistic approaches (which produce a probability distribution of expected portfolio losses) and deterministic approaches (which yield point estimates of an expected portfolio loss).

BHCs using probabilistic approaches should clearly offer evidence that such methods can yield more severe risk scenarios compared to historical scenarios. BHCs should also explain how they utilize tail loss scenarios to detect and address firm-specific risks.

BHCs using deterministic approaches should demonstrate that they have employed a wide range of scenarios, adequately covering their key risk exposures, including mark-to-market positions in the event of firm-specific or market-wide stress conditions. In addition, BHCs should clearly spell out the underlying assumptions employed in stress testing scenarios for risk measurement purposes and corrective measures to fix the identified deficiencies.

Market shock scenarios do not directly incorporate the default of the counterparty. Some BHCs explicitly incorporate the scenario of default of key counterparties (including key customers) while using some sort of probabilistic approach involving some estimates of the PD, LGD, and EAD of counterparties. This method allows BHCs to focus exclusively on the defaults of counterparties to which BHCs have large risk exposure.

BHCs also use assumptions about risk mitigation in the future. Such assumptions, if used, should be conservative in nature. In stress scenarios, the ability of BHCs to take desired actions may be limited.

PPNR Projection Methodologies

PPNR is pre-provision net revenue (i.e., net revenue before adjusting for loss provisions). While estimating revenues and expenses over a planning horizon under stressed conditions (the Capital Plan Rule requires forecasts over the next nine quarters), BHCs should not only take into consideration their current situation, but also the possible future paths of business activities and operational environments related to their on- and off-balance sheet risk exposures, underlying assumptions, and assets and liabilities.

BHCs should also take into consideration the impact of regulatory changes on their performance and ability to achieve their stated targets and goals. Projections should be based on coherent and clearly defined relationships among numerous, relevant variables, such as revenues, expenses, and balance sheet items within a given scenario. For example, assumptions related to origination should be the same for projections related to loans, fees, costs, and losses.

Underlying assumptions for revenues, expenses, and loss estimates should be theoretically and empirically sound, and the central planning group as well as the corporate planning group should be engaged in aggregating projections on an enterprise-wide basis. In the case of limited data, BHCs should employ external data in conjunction with internal data.

Net interest income projections are not isolated projections; rather, they are entrenched with other items of a capital adequacy plan. Balance sheet assumptions should be consistent while projecting net interest income. For example, balance sheet assumptions for projecting net interest income should be the same when estimating loss. Methods employed for projecting net interest income should incorporate ongoing changes in current and projected balance sheet positions.

BHC projections under various scenarios, based on product characteristics (e.g., a change in deposit mix due to increased demand for time deposits), underlying assumptions, and rationale by product should be carefully explained.

BHCs linking loss projections to net interest income projections should clearly establish this link while using modeling approaches, which incorporate the behavioral characteristics of the loan portfolio.

Net interest income projections should be based on methodologies that incorporate discount or premium amortization adjustments for assets not held at par value that would materialize under different scenarios.

New business pricing projections and underlying assumptions, such as constant add-ons to a designated index value, should be compatible with past data, scenario conditions, and BHCs' balance sheet projections.

BHCs should project non-interest income in light of stated scenarios and business strategies. Projection methods should fully encompass underlying major risk exposures and characteristics of a specific business line. For example, an asset management group should project non-interest income using various methods, including brokerage as well as money management revenues.

Additionally, BHCs with trading portfolios should establish a clear link between trading revenue projections to trading assets and liabilities and the compatibility of all the elements of stress scenario conditions.

BHCs with off-balance sheet business items should demonstrate the linkage between revenue projections and changes in on- and off-balance sheet items.

BHCs should not assume perfect correlation between revenues (generated from trading or private equity activity) and broad indices. BHCs should estimate the sensitivity coefficients for changes in revenue as a result of changes in broad index movements.

Furthermore, BHCs holding mortgage servicing rights assets (MSRAs) should carefully design assumptions regarding default, prepayment, and delinquency rates, ensuring that these assumptions are robust and scenario specific. In addition, BHCs that hedge MSRA risk exposure should generate scenario specific assumptions.

For BHCs, projecting volume increases in mortgage loans while ignoring market saturation or other key factors would be an ineffective and weak process, whereas consideration of individual business models, client profiles, and capacity constraint (while projecting mortgage loan volume) would be an effective and strong capital adequacy process.

Macroeconomic relationships should be based on sound theoretical construct and supported by empirical evidence. For example, BHCs may experience a steep decline in credit card fee revenues in a strong recessionary period because of a decline in consumer spending. An example of a weaker practice of a capital planning process is if a BHC does not show a sufficient decline in revenue in stressed conditions despite obvious macro relationships.

In addition, BHCs should utilize a wide set of explanatory variables to develop statistical relationships. BHCs should take into consideration the impact of macroeconomic conditions, such as an economic downturn, on their non-interest expense projections. Non-interest expense projections, like all other projections, should be consistent with revenue and balance sheet estimates and should generate the same underlying strategic assumptions. If projections assume that a decline in revenue (e.g., due to an increase in credit collection costs in an economic downturn) can be offset by some mitigating strategies, BHCs should then clearly demonstrate the feasibility of such actions. Mitigation actions should not be supported by past relationships and actions only because future financial, macro, and global environments may not be as favorable to execute such strategies, as was the case in the past.

Estimation methods to project non-interest expense should focus on uncovering determinants (factors) of individual expense items and how sensitive those factors are to changing macro conditions and business strategies.

Assessing the Impact of Capital Adequacy

BHCs should have a well-defined and well-documented process of generating projections with respect to size and composition of on- and off-balance sheet items and risk-weighted assets (RWA) over a stress horizon period.

Projecting balance sheet items, such as changes in assets and funding, directly without consideration of underlying drivers (of such changes), would be a weak practice. BHCs should identify the impact of changes in key factors on changes in asset and liabilities. Projections should take into consideration these vital relationships.

BHCs should incorporate relationships between revenues, expenses, and balance sheet items into their scenario analyses. Projections about losses, revenues, expenses, and on- and

off-balance sheet items should not be based on favorable underlying assumptions. These assumptions may not stand the trial of uncertain market conditions under stress conditions.

Projections for RWA should be consistent with the projections for risk exposures of on- and off-balance sheet items. All underlying assumptions used for balance sheet and RWA projections should be clearly documented and critically reviewed and validated.

BHCs with a strong process of implementation should form a centralized group responsible for aggregating loss, revenue, expense, on- and off-balance sheets, and RWA projections for enterprise-wide scenario analysis. In addition, BHCs should establish a strong governance structure to critically scrutinize assumptions, methods, and estimates generated in an enterprise-wide scenario analysis and offer needed adjustments. BHCs should carefully evaluate the validity and relevance of underlying assumptions across business lines, portfolios, loss, expense, and revenue estimates if an enterprise-wide scenario analysis produces post-stress results that are more favorable than the baseline conditions. The outcomes of such analyses should also be reconciled for regulatory as well as management reporting purposes.

Key Concepts

LO 50.1

The Federal Reserve's Capital Plan Rule mandates all top-tier, U.S. domiciled bank holding companies with consolidated assets equal to or greater than $50 billion to develop and maintain an effective and robust internal capital plan for evaluating and assessing their capital adequacy.

There are seven principles on which the Federal Reserve assesses the effectiveness of a BHC's internal capital planning, also known as the capital adequacy process (CAP). These seven principles are related to risk management foundation, resource and loss estimation methods, capital adequacy, capital planning and internal controls policies, and governance oversight.

LO 50.2

BHCs should develop a process to effectively identify all of their risk exposures on a firm-wide basis. BHCs should establish a mechanism for a comprehensive, independent, and regular review and validation of all the models used for capital adequacy planning purposes. BHCs should have boards actively involved in evaluating and approving their internal capital adequacy plans. BHCs should develop a capital policy that clearly defines the principles and guidelines for capital goals, issuance, usage, and distributions.

Stress testing and stress scenario design should be based on a variety of factors encompassing all the risk exposures faced by BHCs on a firm-wide basis. With the option of utilizing various quantitative and qualitative methods, BHCs should carefully identify key risk exposures on a firm-wide scenario basis. BHCs should use loss estimation methodologies, which are based on sound theoretical and empirical foundations. BHCs should use a combination of inputs in order to develop loss estimates arising from operational risk. In order to estimate the counterparty credit risk, BHCs mostly use probabilistic or deterministic approaches. BHCs using a probabilistic approach should offer evidence of generating probable scenarios stronger than past observed events. BHCs using a deterministic approach should generate a wide range of stress scenarios.

While estimating pro-provision net revenue (PPNR) projection methodologies, BHCs should pay particular attention to interrelationships among numerous relevant variables such as revenues, expenses, and on- and off-balance sheet items within a given scenario. Methodologies used for projecting net interest income should incorporate ongoing, current, and projected balance sheet positions. BHCs should project non-interest income in light of stated risk scenarios and business strategies.

BHCs should have a well-defined process in place to develop projections of revenues, expenses, losses, on- and off-balance sheet items, and risk-weighted assets in an enterprise-wide scenario analysis. Projections should be based on sound underlying assumptions, interactions, and factors (main drivers of change), and the estimates should be scrutinized, documented, and reported.

Concept Checkers

1. The seven principles of an effective capital adequacy process for bank holding companies (BHCs) subject to the Capital Plan Rule include which of the following?
   I. Oversight from peer BHCs
   II. Annual reporting to the stock exchange (where their stock is listed)
   A. I only
   B. II only.
   C. Both I and II.
   D. Neither I nor II.

2. The Federal Reserve's Capital Plan Rule requires BHCs to maintain an effective process for assessing their capital adequacy for:
   A. BHCs, U.S. or non-U.S. domiciled.
   B. BHCs with more than five years of operational history.
   C. BHCs with a net annual income of more than $5 billion.
   D. BHCs with total consolidated assets of $50 billion or greater.

3. How many of the following statements is most likely correct? BHCs should have risk identification processes that evaluate:
   I. On- and off-balance sheet positions.
   II. Risk transfer and/or risk mitigation techniques.
   III. Changes in institutions' risk profile due to portfolio quality.
   IV. Reputational risk.
   A. One statement.
   B. Two statements.
   C. Three statements.
   D. Four statements.

4. Which of the following statements is most likely correct?
   A. The internal controls policy of BHCs requires that senior management should furnish the board of directors with sufficient information to comprehend the BHC risk exposures.
   B. A governance policy offers fundamental guidelines and principles to BHCs for the capital issuance, use, distribution, and planning purposes.
   C. Suspension or reduction in dividends or repurchase programs do not fall under the capital policy of BHCs.
   D. Designing and testing a scenario-related default of a major counterparty is an example of BHC stress testing and a stress scenario design policy.

5. Which of the following statements is most likely correct?
   I. Under the expected losses methodologies, loss estimation involves three elements: probability of default, loss given default, and exposure at default.
   II. Net interest income projections should incorporate changing conditions for balance sheet positions, including embedded options, prepayment rates, loan performance, and re-pricing rates.
   A. I only.
   B. II only.
   C. Both I and II.
   D. Neither I nor II.

Concept Checker Answers

1. **D** Oversight from peer BHCs and annual reporting to the stock exchange are not included in the seven principles of an effective capital adequacy process.

2. **D** BHCs with total consolidated assets of $50 billion or greater. The other answers are not part of the requirements under the Capital Plan Rule.

3. **D** All of the statements are correct. BHCs should have risk identification processes effectively identifying all risk exposures for assessing capital needs. Reputational risk, like strategic risk and compliance risk, falls under the category of "other risks" and are more difficult to quantify. Nevertheless, there are a wide range of methods BHCs employ to evaluate other risks.

4. **D** The first statement is the requirement of the governance policy and not the internal control policy. The second statement falls under capital policy and not the governance policy. Regarding the third statement, capital contingency plans (e.g., suspension or reduction in dividends or repurchase programs) are a key part of capital policies of BHCs detailing the actions intended to be taken under deficiencies in capital position. The fourth statement is correct. Many different scenarios, including counterparty default, fall under the BHCs' stress testing and scenario design policy.

5. **C** Both statements are correct. Loss estimation involves probability of default, loss given default, and exposure at default. Net interest income projections should incorporate changing conditions for balance sheet positions, including embedded options, prepayment rates, loan performance, and re-pricing rates.

The following is a review of the Operational and Integrated Risk Management principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

Repurchase Agreements and Financing

Topic 51

Exam Focus

Repurchase agreements, or repos, are short-term financing vehicles to borrow/lend funds on a secured basis. The most common repos are for overnight lending. This topic discusses the mechanics of repos, including settlement calculations, the motivations of market participants for entering into repos, as well as the risks (credit risk and liquidity risk) that arise from their use. It also discusses collateral types used in repos, including general collateral and special collateral. For the exam, focus on the characteristics of repo transactions and the primary motivations for using repos. Understanding these motivations should give you a good indication of how and why repos are used in the market, what risks repos hedge, what risks arise from repo trading, and how changes in the market environment affect repos.

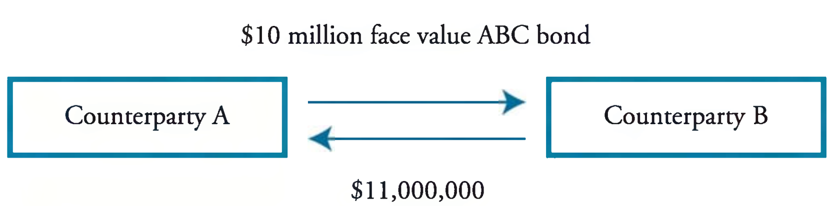
Mechanics of Repurchase Agreements

LO 51.1: Describe the mechanics of repurchase agreements (repos) and calculate the settlement for a repo transaction.

Economically, a **repurchase agreement** (i.e., **repo**) is a short-term loan secured by collateral. Mechanically, it is a contract between two parties where one party sells a security at a specified price with a commitment to buy back the security at a future date at another specified (higher) price. The difference between the sell and buy prices of the security is the implied interest (i.e., return) on the transaction. Repos are used by both borrowers needing short-term funds and by lenders needing short-term investments or access to hard-to-find collateral.

The term repo refers to the transaction from the *borrower*'s side; that is, from the side that sold the security with a promise to buy it back. When we examine the same transaction from the *lender's* side, the transaction is referred to as a **reverse repurchase agreement** (i.e., **reverse repo**). Figures 1 and 2 illustrate an example of a repo trade.

Figure 1: Repo Initiation



Suppose that on May 1, counterparty A wishes to borrow $11 million for 31 days. It therefore sells ABC bonds with a face value of $10 million and a market value of $11 million to counterparty B, with a contract price of $11 million to reflect the bond's market value. Concurrently, counterparty A agrees to buy back the bond in 31 days at the contract price plus 0.3% interest (30 basis points).

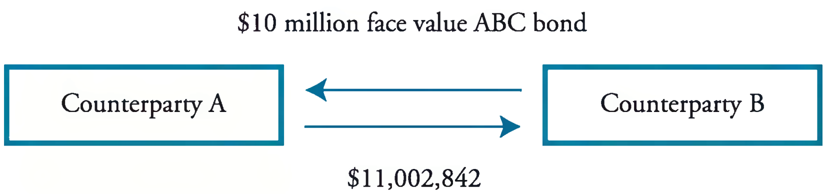
Professor's Note: Interest rates for repos are always quoted at an annualized rate, and the convention for most money market securities is to use an actual/360 day count.

The repurchase price in this example is computed as follows:

$$\$11{,}000{,}000 \times \left(1 + \frac{0.3\% \times 31}{360}\right) = \$11{,}002{,}841.67$$

As illustrated in Figure 2, on the June 1 termination of the repo trade, counterparty A will purchase back the $10 million face value ABC bond for $11,002,842.

Figure 2: Repo Termination (Settlement)



LO 51.2: Explain common motivations for entering into repos, including their use in cash management and liquidity management.

Borrowers in Repos

From the perspective of the *borrower*, repos offer relatively cheap sources of obtaining short-term funds. Relative to unsecured borrowing, repos allow the borrower to obtain funds at favorable rates because lenders are willing to accept lower returns (relative to unsecured transactions) in favor of the security of collateral.

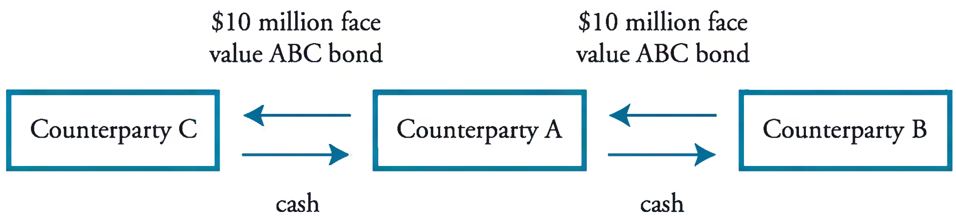
Bond Financing

Repos can also be used to obtain cash to finance a long security position. Consider a financial institution in the previous example (as counterparty A) that just purchased the same $10 million face value ABC bond from a client in hopes of selling it to another investor for a profit. Until the new buyer is found, however, the financial institution needs to finance the purchase of the bond. It can do so by borrowing cash through an overnight repo trade (from counterparty B) and pledging the ABC bond as collateral, subject to any applicable haircuts. If the financial institution cannot immediately find a buyer, it needs to roll/renew its position. If the initial repo trade and the subsequent rolls are transacted with the same counterparty, the trade flow is similar to Figure 1.

If the repo is renewed/rolled with a different counterparty, the financial institution first needs to unwind the initial trade (with counterparty B) and then enter into a new repo trade with another counterparty (counterparty C). This is illustrated in Figure 3.

Similar to financing a bond purchase, the financial institution may also use repos to finance proprietary positions or to finance its inventory in order to make markets.

Figure 3: Back-to-Back Repo Trades



Liquidity Management

Firms can borrow funds in different ways. They can issue equity capital or issue long-term or short-term debt, either on a secured or unsecured basis. Repos offer secured short-term financing; however, they are considered less stable given that repos need to be repaid within a short time period, and they are subject to swings in market conditions and sentiment. By contrast, equity financing is considered the most stable financing form given that the issuing firm has no obligation to pay dividends and equity financing does not need to be paid back. However, given its stability, equity financing is the most expensive and requires the highest expected return. By contrast, repo financing is cheaper but less stable.

Firms need to balance this tradeoff between the costs of funding among the various alternatives and potentially being left without financing. This is referred to as **liquidity management.**

Lenders in Repos

From the perspective of the *lender*, repos can be used for either investing or for financing purposes as part of an entity's cash management or financing strategies.

Cash Management (Repos as Investment Vehicles)

Lenders use repos (taking the reverse repo side) for investing when they hold cash either for liquidity or safekeeping reasons and need short-term investing opportunities to generate return on their surplus cash position. For example, money market mutual funds hold cash for safekeeping on behalf of investors and therefore need low risk, short maturity investments to generate return rather than holding idle cash. Municipalities, on the other hand, have significant surplus cash generated from tax revenues. Municipalities are prohibited from investing in high-risk investments, and repos offer a low risk, collateral-secured investment opportunity.

Investors look for liquidity and tend to favor very short-term positions in **overnight repos**, which provide significant flexibility to the investor. Following each overnight repo

transaction, the investor could re-evaluate its decision whether to continue lending cash. Investors may also transact in **open repos** by lending for a day under a contract that renews each day until it is canceled. Repos could have longer maturities out to several months, although typically the longer the maturity, the lower the overall demand.

In addition to liquidity, investors also prefer higher quality collateral. Repo collateral is generally limited to high-quality securities, including securities issued or guaranteed by governments and government-sponsored entities. Because the lender is faced with the risk of a decline in collateral value during the term of the repo transaction, repo agreements often require collateral haircuts. A **haircut** refers to discounting the value of the collateral posted in relation to its risk. In our earlier repo trade example, counterparty B may only lend $10.5 million against the $11 million market value of the ABC bond collateral received. Finally, repo transactions are also subject to margining and (daily) margin calls. A margin call requires a borrower to post additional collateral in a declining market, but it also allows the borrower to withdraw excess collateral in up markets.

Short Position Financing (Repos as Financing Vehicles)

Lenders may also use repos (as the reverse repo side) to finance short positions in bonds. Consider an investment management firm that has a view that interest rates will rise and bond prices will fall. It can take advantage of this view by obtaining the desired bond collateral through lending cash in a reverse repo trade. It would then short sell the bond received through the reverse repo and buy it back at the market price at a later date, hoping to benefit from the trade from a fall in prices. The transaction flows would be similar to what we previously illustrated in Figure 1 and Figure 2, with the investment management firm as counterparty B.

Counterparty Risk and Liquidity Risk

LO 51.3: Explain how counterparty risk and liquidity risk can arise through the use of repo transactions.

Repo transactions involve the exchange of cash as well as the exchange of collateral. As a result, both counterparty risk (credit risk) and liquidity risk are present.

Counterparty risk is the risk of borrower default or non-payment of its obligations, and it arises because the lender is exposed to the risk of a failure by the borrower to repay the repo loan and interest. Given, however, that repo loans are secured by collateral, this makes the lender much less vulnerable to a decline in the creditworthiness of the borrower. The lender can recover any amounts owed by simply selling the collateral. As a result, because repos are generally very short-term transactions secured by collateral, counterparty (credit) risk is less of a concern.

Liquidity risk is the risk of an adverse change in the value of the collateral and can be of particular concern to the lender. Even if the lender is less concerned with the credit risk of a counterparty given the security of collateral, the lender is still exposed to the risk of collateral illiquidity and to the value of the collateral declining during the repo term. Especially during times of market turbulence (as we will see in next LO), the value of

collateral can decline significantly and its liquidity can dry up. This risk can be mitigated with the use of haircuts, margin calls, reducing the term of the repo, and accepting only higher quality collateral.

Repos During the Credit Crisis

LO 51.4: Assess the role of repo transactions in the collapses of Lehman Brothers and Bear Stearns during the (2007–2009) credit crisis.

Prior to the 2007–2009 credit crisis, the repo market was considered relatively liquid with stable demand by both borrowers and lenders. Borrowers often posted weaker quality collateral, including corporate bonds or mortgage-backed securities. This benefited both borrowers, who were able to post less desirable collateral, and lenders, who were able to obtain higher repo rates in exchange for accepting lower quality collateral. However, as the crisis escalated, lenders were reluctant to continue to accept these securities, and were increasingly demanding higher quality collateral and larger haircuts. At the extreme, they simply withdrew liquidity and stopped transacting in the markets. Borrowers that were the worst hit experienced collateral liquidations, capital declines, and ultimately bankruptcies. The case studies of Lehman Brothers and Bear Stearns provide important insights into the role of repo transactions in the demise of these once important institutions.

Repos and Lehman Brothers

JPMorgan Chase & Co. (JPM) was the tri-party repo clearing agent of Lehman Brothers Holdings, Inc. (Lehman). (In a tri-party repo agency arrangement, the repo trades are still executed between two counterparties; however, the collateral selection, payment, settlement, and repo management is outsourced to a third-party agent. Agents are essentially custodians and do not take on the risks of the transactions.) These tri-party repos were traded in the overnight market, and were transacted predominantly between institutional repo lenders and financial institution borrowers (including Lehman). Given that the trades were overnight transactions, they matured each morning, leaving the borrowers without funding during the rest of the day. To bridge this funding gap, JPM, as tri-party agent, was lending directly to Lehman on a secured basis during the day, typically without requiring haircuts on intraday advances. By August 2008, however, due to the increased risk in the repo markets, JPM began to phase in haircuts on intraday loans, with the loan amounts exceeding $100 billion in the final week of Lehman's bankruptcy.

Professor's Note: Lehman was one of the largest U.S. investment banks. The failure of Lehman in September 2008 was the largest in U.S. history ($600 billion in assets).

Both Lehman and JPM provide different viewpoints of the events leading up to Lehman's bankruptcy in September 2008. Despite the differing accounts, it is clear that the liquidity and value of collateral pledged in repo transactions declined during the crisis, and additional collateral and additional haircuts were necessary to mitigate the risks in repos.

According to Lehman, JPM, despite a conflict of interest due to its agent and lender role, breached its duty to Lehman and took advantage of its insider status (being insider to Lehman's internal financial condition and proposed business plans). Lehman accused JPM of using its influence to drain close to $14 billion in collateral from Lehman during the last few days before the bankruptcy, despite already being in an overcollateralized position. Although Lehman agreed at the time to provide additional collateral, it did so unwillingly and simply because there were no viable alternatives.

According to JPM, however, JPM acted in good faith by providing continued funding to Lehman up until the last day, despite Lehman's deteriorating financial condition. When it became clear that the collateral posted to JPM by Lehman was illiquid with apparently overstated values, JPM's exposure to Lehman was growing at a time when Lehman's creditworthiness and financial condition was deteriorating. Nevertheless, JPM continued to lend money despite inadequate haircuts and collateral values. The close to $14 billion in additional collateral requested by JPM was significantly less than what was needed to cover JPM's true exposure.

Repos and Bear Stearns

Prior to 2007, Bear Stearns Companies, Inc., (Bear Stearns) relied on funding its borrowings primarily in the form of short-term unsecured commercial paper. By 2007, however, Bear Stearns switched from unsecured borrowing to a more stable form of borrowing through longer term, secured repo financing, which better positioned the firm to withstand market liquidity events. Given the high-quality collateral posted, the firm was able to obtain financing at favorable rates on a term basis.

Given the events of 2007–2009, lenders during this period became increasingly less willing to provide loans in the form of repo trades, and were especially averse to providing term (rather than overnight) repos. This led to a general shortening of repo terms, requiring larger haircuts, and requesting borrowers to post higher quality collateral. In early March 2008, Bear Stearns experienced a run on the bank that resulted from a general loss of confidence in the firm. This bank run led to a massive withdrawal of cash and unencumbered assets (i.e., assets that have not been committed or posted as collateral), and lenders refused to roll over their repo trades. The rapid decline in market confidence and withdrawal of capital ultimately led to Bear Stearns' collapse.

Professor's Note: Bear Stearns was a U.S. investment bank and brokerage firm that was bailed out by the Federal Reserve Bank of New York and subsequently sold to JPM in March 2008.

Collateral in Repo Transactions

LO 51.5: Compare the use of general and special collateral in repo transactions.

Repo trades can be secured either with general collateral or with specific (i.e., special) collateral.

General Collateral

While lenders care about the quality of collateral delivered, under **general collateral** (GC), repo lenders are not concerned with receiving a particular security or class of securities as collateral. Instead, only the broad categories of acceptable securities are specified. The logic here is that when lenders are looking to receive a specific rather than generic security as collateral, this creates a demand for that security and lenders have to accept a lower return on the repo trade. GC trades suit investors in repos because they can obtain the highest repo rate for the collateral received.

The repo rate for trades secured with general collateral is called the **GC rate**. GC rates can be used for repos with U.S. Treasury collateral, and the overnight rate for U.S. Treasury collateral is referred to as "the" GC rate. In the United States, the GC repo rate is typically slightly below the federal funds rate, although repos with U.S. Treasury collateral are considered safer and in fact can trade below the federal funds rate. The difference between the federal funds rate and the GC rate is measured through the **fed funds-GC spread**. This spread widens when Treasuries become scarcer (the GC rate falls) or during times of financial stress, as was the case during the recent financial crisis.

Professor's Note: The federal funds rate is an interest rate that depository institutions in the United States charge each other for lending funds maintained at the Federal Reserve.

Special Collateral

When lenders are concerned with receiving a particular security as collateral, the collateral is referred to as **special collateral**, and the repo trade is called a **specials trade**. If you recall our discussion on financing as a motivation for repo lending, it should be clear that specials trades are particularly important in financing transactions used to obtain specific bonds. The repo rate for trades secured with special collateral is called the **special rate**.

In specials trading, the lender of cash is concerned with receiving a particular security in order to finance the purchase of a bond (for shorting), or to finance its inventory or proprietary positions. Lenders accepting special collateral face a trade-off between receiving the desired security and lending at below GC rates to receive the desired security. Special rates differ by security because there is a rate for each security for each term. Special rates are determined by market supply and demand; however, it is important to note that the supply and demand of the underlying security is not the same as the supply and demand of the specials trade itself. In fact, a bond that is in high demand in the market may not be in great demand as collateral for a specials trade. The reverse could equally be true.

Special Spreads and the Auction Cycle

LO 51.6: Describe the characteristics of special spreads and explain the typical behavior of US Treasury special spreads over an auction cycle.

The difference between the GC rate and the special rate for a particular security and term is called a **special spread**. Special spreads are important because in the United States, they are tied closely to the U.S. government Treasury bond auctions, and the level and volatility of the spread can be an important gauge of market sentiment.

In the United States, federal government bonds are sold at auction based on a predetermined, fixed schedule. The most recent issue is called the **on-the-run** (OTR) or *current* issue, while all other issues are called **off-the-run** (OFR). Current OTR issues tend to be the most liquid, with low bid-ask spreads, that can be liquidated quickly even in large sizes. This liquidity makes them desirable for both long positions and short positions. For example, a repo lender would favor these securities for short positions because the shorts could be covered quickly and at a relatively low cost. The popularity of OTR issues as special collateral in repo trades historically resulted in lower repo rates and wider special spreads.

Several observations can be made by looking at the special spreads of OTR Treasury securities (OTR special spreads) and the auction-driven pattern of special spreads. First, OTR special spreads can be volatile each day depending on the special collateral. Second, spreads can fluctuate over time. Third, and most important, OTR special spreads are generally narrower (smaller) immediately after an auction but wider before auctions. They are narrower after auctions due to the extra supply of a new OTR security, which depresses special spreads. Spreads widen before auctions due to the substitutability of the special collateral as shorts change to the new OTR security.

The influence of auctions can also be observed from the term structure of individual OTR issues based on term special spreads (the difference between term GC rates and term special rates). Term special spreads are expected to decline immediately following the issue of the new OTR security but increase closer to the dates of the new auctions.

Special Spreads and Rate Levels

Special spreads generally move within a band that is capped at the GC rate (implying a floor of 0% for the special rate). When a trader short sells the OTR Treasury security but fails to deliver on settlement, the trader would not receive cash from the sale and would also miss out on a day's interest on the cash. To satisfy the settlement obligation to deliver the bond, the trader could borrow the bond in the overnight repo market and pay a special rate of 0% (essentially the trader provides free financing in exchange for receiving the desired bond). At any rate below 0%, no trader would borrower the bond. This puts both an effective lower bound and an effective cap of the special spread at the GC rate.

The special spread can also be tied to the penalty for failed trades. Until 2009, there was no penalty for failed trades. However, in light of the financial crisis and trillions of dollars in failed OTR deliveries, regulators adopted a penalty rate for failed trades, equal to the greater of 3% minus the federal funds rate, or zero. This means that as the federal funds rate

increases, the penalty falls, and when the federal funds rate declines to zero, the penalty rate reaches its maximum at 3%. As a result, the new upper limit for the special spread is the penalty rate.

LO 51.7: Calculate the financing advantage of a bond trading special when used in a repo transaction.

The premium trading value of OTR bonds is due both to their liquidity and financing advantage as we previously discussed. The liquidity advantage stems from the ability to sell these bonds quickly for cash. The financing value stems from the ability to lend the bonds at a cheap special rate and use the cash to lend out at higher GC rates. This financing value is dependent on the trader's expectation of how long the bond will continue trading at its special rate before the rate moves higher toward the GC rate.

Let's assume that an OTR bond is issued on January 1 and trades at a special spread of 0.18%. A trader expects the bond to trade at GC rates past March 31. The financing value of the OTR bond is therefore the value over 90 days. The value of \$100 of cash at the spread of 0.18% is:

$$\$100 \times \frac{90 \times 0.18\%}{360} = \$0.045$$

Thus, the financing value is 4.5 cents per \$100 market value of the bond.

Key Concepts

LO 51.1

Repurchase agreements, or repos, are bilateral contracts where one party sells a security at a specified price with a commitment to buy back the security at a future date at a higher price. From the perspective of the borrower we refer to repos, while from the perspective of the lender we refer to reverse repos. Repos are valued based on a simple time value of money calculation.

LO 51.2

From the perspective of the borrower, repos offer relatively cheap sources of obtaining short-term funds. Balancing the cost of funding (e.g., through repos) and other sources of funds (including potentially no funding) is called liquidity management.

From the perspective of the lender, repos can be used for either investing (cash management) or for financing purposes (e.g., to finance short bond positions).

LO 51.3

Repos give rise to both counterparty risk and liquidity risk. Counterparty (credit) risk is the risk of borrower default or non-payment of its obligations. Liquidity risk is the risk of an adverse change in the value of the collateral. Counterparty risk is mitigated with collateral, while liquidity risk is mitigated with haircuts, margin calls, shorter repo terms, and higher quality collateral.

LO 51.4

During the recent financial crisis, lenders were increasingly demanding higher quality collateral and larger haircuts and even withdrew liquidity altogether. Borrowers experienced collateral liquidations and capital declines, leading to several high profile company failures and bankruptcies. The failures of Bear Stearns and Lehman Brothers illustrate these events.

LO 51.5

Repo trades can be secured either with general collateral or with specific collateral. Lenders (as investors) in general collateral (GC) repo trades are not concerned with receiving a specific security, and only the broad categories of acceptable securities are specified. GC trades suit investors in repos because they can obtain the highest repo rate for the collateral received. Lenders (as financing participants) in special collateral repo trades (specials trades) are concerned with receiving a particular security as collateral. The particular security received can then be used to finance the purchase of a bond (for shorting) or to finance its inventory or proprietary positions.

LO 51.6

The difference between the GC rate and the special rate for a particular security and term is called a special spread. Special spreads are tied closely to Treasury bond auctions, and the level and volatility of the spread can be an important gauge of market sentiment. Special spreads are generally narrower immediately after an auction, but widen before auctions. Spreads generally move within a band that is capped at the GC rate (implying a floor of 0% for the special rate).

Following the recent financial crisis, regulators adopted a penalty rate for failed trades at the greater of 3% minus the federal funds rate, or zero. As a result, the penalty rate becomes the new upper limit for the special spread.

LO 51.7

The financing value of the bond is the ability to lend the bonds at a relatively cheap special rate and use the cash to lend out at higher GC rates. This financing value is dependent on the trader's expectation of how long the bond will continue trading at its special rate.

Concept Checkers

1. Pasquini Investments (Pasquini) is a private brokerage looking for 30-day financing of $25 million of its accounts payable but is unsure whether the appropriate investment is a term repurchase agreement (repo) or a term reverse repo agreement. Pasquini is willing to post AAA-rated government bonds as collateral. The bonds have a face value of $27 million and a market value of $25 million. The firm is quoted a rate of 0.5% for the transaction. Which of the following choices most accurately reflects the contract type and the contract price needed by Pasquini?

	Contract type	Contract price
A.	Repo	$27,011,250
B.	Reverse repo	$25,010,417
C.	Repo	$25,010,417
D.	Reverse repo	$27,011,250

2. Posting collateral and requiring collateral haircuts are important risk mitigants in repo transactions with respect to which of the following risks?

	Posting collateral	Collateral haircuts
A.	Market risk	Interest rate risk
B.	Credit risk	Interest rate risk
C.	Market risk	Liquidity risk
D.	Credit risk	Liquidity risk

3. Kotra Bank Holdings, Inc., (Kotra) is currently weighing the cost of its funding against the risk of being left without financing. The term that best describes Kotra's activities is:
   A. counterparty (credit) risk.
   B. specials trading.
   C. liquidity management.
   D. overnight funding.

4. In a presentation to management, a bond trader makes the following statements about repo collateral:

   Statement 1: *"The difference between the federal funds rate and the general collateral rate is the special spread."*

   Statement 2: *"During times of financial crises, the spread between the federal funds rate and the general collateral rate widens."*

   Which of the trader's statements are accurate?
   A. Both statements are incorrect.
   B. Only Statement 1 is correct.
   C. Only Statement 2 is correct.
   D. Both statements are correct.

5. The latest on-the-run (OTR) Treasury bond issued on March 1 is trading at a special spread of 0.25%. Traders expect the bond to trade at general collateral (GC) rates past June 30. The financing value of the OTR bond is therefore the value over 122 days. Given this information, the value of lending \$100 of cash is closest to:
   A. \$0.085.
   B. \$0.250.
   C. \$0.305.
   D. \$0.847.

Concept Checker Answers

1. **C** Given that Pasquini is a borrower in the repo market, the transaction is a repo from the perspective of the firm (but a reverse repo from the perspective of the lender). The contract price is calculated as follows:

$$\$25{,}000{,}000\times\left(1+\frac{0.5\%\times30}{360}\right)=\$25{,}010{,}417$$

2. **D** Collateral is an important counterparty credit risk mitigant. Repo loans are secured by collateral, which makes the lender much less vulnerable to a decline in the creditworthiness of the borrower. Collateral haircuts are important in mitigating liquidity risk in repo transactions. The lender is exposed to the risk of the value of the collateral declining during the repo term, which can be mitigated by requiring (higher) haircut values, that is, discounts to the value of the posted collateral.

3. **C** The process of weighing the cost of its funding against the risk of being left without financing is called *liquidity management*. Counterparty (credit) risk is the risk of borrower default or non-payment of its obligations. In specials trading, a lender of cash initiates a repo trade in order to receive a particular security (special collateral). Overnight funding refers to borrowing and lending in the overnight market.

4. **C** The trader's first statement is incorrect. The difference between the federal funds rate and the general collateral (GC) rate is known as the *fed funds-GC spread*. The *special spread* is the difference between the GC rate and the special rate for a particular security.

   The trader's second comment is correct. During times of financial crises, the spread between the federal funds rate and the general collateral rate widens as the willingness to lend Treasury securities declines, lowering the GC rate (thereby increasing the spread).

5. **A** The financing value of \$100 of cash at a spread of 0.25% is calculated as:

$$\$100\times\frac{122\times0.25\%}{360}=\$0.0847\text{ or }8.47\text{ cents}$$

The following is a review of the Operational and Integrated Risk Management principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

Estimating Liquidity Risks

Topic 52

Exam Focus

This topic addresses the calculation of liquidity cost and applies this value to the value at risk measure. We will see how to compute liquidity-adjusted VaR (LVaR) when considering both a constant spread and an exogenous spread approach. Be familiar with how to make these calculations, particularly for the constant spread approach. Also, understand the concept of cash flow at risk (CFAR) and how liquidity is impacted during a crisis.

Liquidity Risk

LO 52.1: Define liquidity risk and describe factors that influence liquidity, including the bid-ask spread.

Liquidity risk is the degree to which a trader cannot trade a position without excess cost, risk, or inconvenience. When liquidity risk exists, there can be several types of price uncertainty. First, the usual market quote of the average of the bid and ask prices becomes less meaningful because the spread is wider, which means the market quote is even farther from either the buy or sell transaction price. Second, a larger bid-ask spread means a higher cost to get in and out of the position. Third, the actual price of either a buy or sell order is less certain because the assets do not trade frequently, and the quoted bid and ask prices will probably not be the prices of the respective sell and buy transactions when actually executed. There is also an increased risk in that the spread can change (i.e., it is stochastic), which will increase the risks of trading.

Liquidity is a function of the type of market and its characteristics. It depends on factors such as the number of traders in the market, the frequency and size of trades, the time it takes to carry out a trade, the cost, and the risk of the transaction not being completed. It also depends on the type of asset and the degree to which the asset is standardized. A less standardized asset will have higher liquidity risk. A forward contract has much more liquidity risk than a futures contract, for example, because the forward contract is not a standardized contract. Over-the-counter (OTC) derivatives of all types usually have relatively high liquidity risk.

Bid-Ask Spread

The bid-ask spread is a cost of liquidity. A wider (narrower) spread indicates lower (higher) liquidity. If an asset becomes less liquid, the spread increases, and the costs of trading the asset increase. The risk of liquidity changing, and changes in the spread, should be included with other measures of market risk. The spread can also change as a result of the activities of a given trader when liquidity is endogenous, which is described in the next LO.

Exogenous vs. Endogenous Liquidity

LO 52.2: Differentiate between exogenous and endogenous liquidity.

Exogenous liquidity refers to the bid-ask spread not being affected by the individual trades made by investors. This is more likely to be the case when the trades are relatively small. **Endogenous liquidity** refers to when a given trade can influence the liquidity risk of the trade (i.e., a trader submitting a buy or sell order that increases the spread). If an investor attempts to purchase a large block of an asset, for example, the buy order may have an impact on the spread and increase the cost over that indicated by the initial bid-ask prices. This can also happen when an investor tries to liquidate an asset. This type of endogeneity problem is more likely in illiquid markets and when the trade is large relative to the market.

In summary, for endogenous markets, if a trader attempts to liquidate (buy) a large position, the trader should expect the bid (ask) price to fall (increase) and the bid-ask spread to widen. The trader should include such a market reaction when estimating liquidity costs and risks. In both the endogenous and exogenous case, the bid-ask spread is still a function of the factors already mentioned (the number of traders, the standardization of the asset, low transactions costs, etc).

Liquidity-Adjusted VaR

LO 52.3: Describe the challenges of estimating liquidity-adjusted VaR (LVaR).

One of the challenges of estimating liquidity-adjusted value at risk (LVaR) is choosing the best method. As in most choices, there is a tradeoff between sophistication and ease of implementation, and it is worth noting that sophistication and usefulness are not necessarily positively correlated. It is recommended to find approaches that are transparent in their assumptions and simple to implement (e.g., implementable with just a spreadsheet). A good way to do this is to determine liquidity "add-ons" that allow a researcher to modify original VaR estimates that did not include factors for illiquidity. In addition to addressing liquidity, the approach can also assess the impact of assumptions on estimates of VaR.

Another challenge is liquidity adjustments that are compatible with the basic VaR approach and each other. This is because different methods look at different aspects of illiquidity, and it can be helpful to combine 'add-ons' that give the best overall liquidity adjustment. In other words, two less sophisticated methods may be much better than one really good sophisticated method.

Another challenge is to check how the liquidity adjustment changes other inputs, such as the confidence level, holding period, or any other parameters (i.e., the sensitivity of the other inputs to the liquidity adjustment). The researcher should be aware of some basic relationships (e.g., an increase in the holding period should lower the level of the liquidity adjustment).

The researcher should try to calibrate the model against real data (e.g., check if the bid-ask spread parameters are empirically plausible), and properly stress test the model, as well as backtest the model. The researcher should be aware that there is probably not a single, best

approach that would exclude the use of all others. Furthermore, using different approaches can help highlight different liquidity concerns.

LO 52.4: Describe and calculate LVaR using the constant spread approach and the exogenous spread approach.

The **constant spread approach**, as the name implies, calculates LVaR assuming the bid-ask spread is constant. This makes the liquidity cost equal to half the spread multiplied by the size of the position to be liquidated. The liquidity cost (LC) to add on to the initial VaR estimate is then:

$$LC = 0.5 \times V \times \text{spread}$$

where:
V = value of the position

$$\text{spread} = \frac{(\text{ask price} - \text{bid price})}{(\text{ask price} + \text{bid price})/2}$$

Recall that VaR quantifies the maximum loss for a given confidence level over a particular holding period. For example, a typical VaR calculation may indicate a 1% probability of losses exceeding $10 million over a five-day holding period. LVaR is calculated using the following formula assuming a constant spread:

$$LVaR = (V \times z_{\alpha} \times \sigma) + [0.5 \times V \times \text{spread}]$$

$$LVaR = VaR + LC$$

where:
V = asset (or portfolio) value
z_{α} = confidence parameter
σ = standard deviation of returns

Professor's Note: Notice that VaR in this example is dollar VaR as opposed to percentage VaR.

The confidence level of the estimate is $1 - \alpha$ (e.g., 5% level of significance (α) = 95% confidence level). Note that the larger the spread, the larger the calculated LVaR. Since liquidity risk incorporates selling the asset, not a full "round trip," only half of the spread is used.

Example: Computing LVaR

Suppose that ABC Company has a current stock price of \$100 and a daily standard deviation of 2%. The current bid-ask spread is 1%. **Calculate** LVaR at the 95% confidence level. Assume a constant spread.

Answer:

$$\text{LVaR} = (100 \times 1.65 \times 0.02) + (0.5 \times 100 \times 0.01) = \$3.80$$

The previous discussion involved the use of normal VaR (i.e., VaR assuming asset prices are normally distributed). In practice, asset prices are lognormally distributed as was illustrated in the FRM Part I curriculum when we examined the Black-Scholes-Merton option pricing model. In this assigned reading, the author uses **lognormal VaR** to calculate the liquidity-adjusted VaR. The conventional lognormal VaR, with no adjustment for liquidity risk, is calculated in the following fashion:

$$\text{Lognormal VaR} = [1 - \exp(\mu - \sigma \times z_\alpha)] \times V$$

where:
μ = mean return

The liquidity-adjusted VaR is then calculated as follows:

$$\text{LVaR} = \text{VaR} + \text{LC} = [1 - \exp(\mu - \sigma \times z_\alpha) + 0.5 \times \text{spread}] \times V$$

Using the simplifying assumption of $\mu = 0$, the ratio of LVaR to VaR becomes:

$$\frac{\text{LVaR}}{\text{VaR}} = 1 + \frac{\text{spread}}{2 \times [1 - \exp(-\sigma \times z_\alpha)]}$$

This expression indicates that the liquidity adjustment will increase (decrease) when there is an increase (decrease) in the spread, a decrease (increase) in the confidence level, and a decrease (increase) in the holding period.

Professor's Note: Notice that the calculation of lognormal VaR and normal VaR will be similar when we are dealing with short-time periods and practical return estimates.

Example: Computing LVaR to VaR ratio (constant spread)

Assume the following parameters: $\mu = 0$, $\sigma = 0.012$, spread = 0.02, and a 95% confidence level. **Compute** the LVaR to VaR ratio.

Answer:

$$\frac{\text{LVaR}}{\text{VaR}} = 1 + \frac{0.02}{2 \times [1 - \exp(-0.012 \times 1.65)]} = 1.51$$

The increase from VaR to LVaR is just over 50%, from only a 2% spread. This demonstrates that even a small spread can translate into a surprisingly large liquidity adjustment to VaR.

LVaR can also be calculated given the distribution characteristics of the spread. This is the foundation underlying the **exogenous spread approach.** If you are given the mean and standard deviation of the spread, you would apply the following formula:

$$\text{LVaR} = \text{VaR} + 0.5 \times [(\mu_S + z'_\alpha \times \sigma_S)] \times V$$

Professor's Note: We add the confidence parameter times the volatility of the spread to the mean of the spread since the liquidity adjustment increases the value at risk. Also, notice that the confidence parameter (or z-score) used for the uncertainty of the spread is labeled differently. The confidence parameter, in this case, is a value to be determined.

The exogenous spread approach assumes that the spread is stochastic and that the trades of a single trader do not affect the spread. The spread could follow one of many distributions; for example, the normal distribution or a more leptokurtic distribution (historically, the distribution of the spread has been highly non-normal with excess amounts of kurtosis). Once having assumed a distribution, the researcher can estimate the LVaR using Monte Carlo simulation by simulating values for both *V* and the spread, incorporating the spread into *V* to get liquidity-adjusted prices, and then infer the liquidity-adjusted VaR from the distribution of simulated liquidity-adjusted prices.

Example: Computing LVaR (assuming normal VaR)

Suppose that ABC Company has a current stock price of $100 and a daily standard deviation of 2%. The mean of the bid-ask spread is 2%, and the standard deviation of the bid-ask spread is 1%. **Calculate** LVaR at the 95% confidence level assuming the confidence parameter of the spread is equal to 3.

Answer:

$$\text{LVaR} = (100 \times 1.65 \times 0.02) + \frac{1}{2} 100 \times (0.02 + 3 \times 0.01) = \$5.8$$

The researcher can determine the optimal value of z'_α using some suitably calibrated Monte Carlo exercise [Bangia et al. (1999)[1] assume a value of three for z'_α]. Applying lognormal assumptions, the LVaR using the exogenous spread approach is the lognormal VaR plus the liquidity adjustment:

$$\text{LVaR} = \text{VaR} + \text{LC} = V \times \{[1 - \exp(\mu - \sigma \times z_\alpha)] + [0.5 \times (\mu_S + z'_\alpha \times \sigma_S)]\}$$

It is worth noting that if σ_S equals zero, then this expression becomes the LVaR formula for the constant spread approach where μ_S = spread. Thus, this approach is simply the constant spread approach with an added expression to allow for a stochastic spread.

We can now apply the familiar LVaR to VaR ratio:

$$\frac{\text{LVaR}}{\text{VaR}} = 1 + \frac{\text{LC}}{\text{VaR}} = 1 + \frac{(\mu_S + z'_\alpha \times \sigma_S)}{2 \times [1 - \exp(-\sigma \times z_\alpha)]}$$

Example: Computing LVaR to VaR ratio (exogenous spread)

A researcher estimates the mean and standard deviation of the spread to be 0.02 and 0.005, respectively. He also estimates that $\mu = 0$ and $\sigma = 0.012$ for the underlying returns distribution. Using a 95% confidence level, **compute** the ratio of LVaR to VaR. Assume the confidence parameter for the spread, z'_α, is equal to 3.

Answer:

$$\frac{\text{LVaR}}{\text{VaR}} = 1 + \frac{(0.02 + 3 \times 0.005)}{2 \times [1 - \exp(-0.012 \times 1.65)]} = 1.89$$

The result here, when compared to the previous answer, demonstrates how including the possibility of the spread being random (stochastic) can increase the liquidity adjustment. In this case, it almost doubles from 51% to 89%.

Endogenous Price Approaches

LO 52.5: Describe endogenous price approaches to LVaR, their motivation and limitations, and calculate the elasticity-based liquidity adjustment to VaR.

Both the constant spread approach and the exogenous spread approach assume that prices do not change in response to trading (i.e., prices are exogenous). This may not always be the case, and it may be necessary to make a liquidity adjustment for endogenous prices. In the case of selling for example, there may be downward pressure on prices, which causes a loss. VaR should include an adjustment for the possibility of this loss. The adjustment should be larger if the market prices are more responsive to trades.

1. Bangia, A.F. Diebold, T. Schuermann, and J. Stroughair. (1999). "Liquidity on the outside." *Risk* 12 (June): 68–73.

Of the various ways to include an adjustment, a relatively simple method uses the concept of **elasticity**, *E*. In this case, it is the proportional change in price divided by the proportion of the market traded:

$$E = \frac{\Delta P/P}{\Delta N/N}$$

where:
$\Delta N/N$ = size of the trade relative to the entire market

Generally, it is the case that $E < 0$ and $\Delta N/N > 0$. A researcher can estimate values for *E* and $\Delta N/N$ and input them into an expression for LVaR as follows:

$$\text{LVaR} = \text{VaR} \times \left(1 - \frac{\Delta P}{P}\right) = \text{VaR} \times \left(1 - E \times \frac{\Delta N}{N}\right)$$

$$\frac{\text{LVaR}}{\text{VaR}} = 1 - E \times \frac{\Delta N}{N}$$

The approach is very convenient because the adjustment is independent of the computation of VaR and its assumptions, and the ratio of LVaR to VaR is a function of only two inputs. The obvious limitation is its narrow focus and that it entirely ignores bid-ask spreads and transactions costs. On the other hand, a researcher can easily combine this adjustment with one of the other liquidity adjustments by simply multiplying the effects:

$$\left.\frac{\text{LVaR}}{\text{VaR}}\right|_{\text{combined}} = \left.\frac{\text{LVaR}}{\text{VaR}}\right|_{\text{exogenous}} \times \left.\frac{\text{LVaR}}{\text{VaR}}\right|_{\text{endogenous}}$$

Example: Endogenous price approach

A trader has a position worth 10% of the size of the market (i.e., $\Delta N/N = 0.1$) and estimates that $E = -0.4$ so that $\Delta P/P = E \times \Delta N/N = -0.4 \times 0.1 = -0.04$. **Compute** the ratio of LVaR to VaR based only on endogenous factors and the combined LVaR to VaR ratio assuming the ratio for the exogenous approach is 1.89.

Answer:

$$\left.\frac{\text{LVaR}}{\text{VaR}}\right|_{\text{endogenous}} = 1 - (-0.04) = 1.04$$

Thus, the adjustment for endogeneity will increase the total adjustment for liquidity by 4%. Using the liquidity adjustment for the exogenous approach yields the following combined result:

$$\left.\frac{\text{LVaR}}{\text{VaR}}\right|_{\text{combined}} = 1.89 \times 1.04 = 1.97$$

Jarrow and Subramanian (1997)[2] offer a more sophisticated method called the **liquidity discount VaR**, where the trader maximizes expected utility by liquidating the position within a certain period of time. It incorporates both exogenous and endogenous market liquidity, spread cost, spread risk, an endogenous holding period, and an optimal liquidation policy. It does so with three modifications: (1) uses an optimal holding period based on the trader's expected-utility optimization problem, (2) adds the average liquidity discount to the trader's losses, and (3) has the volatility measure include the volatility of the time to liquidation and the volatility of the liquidity discount factor, as well as the volatility of the underlying market price.

Liquidation, Transactions Costs, and Market Price Impact

As with most ancial activities, there are tradeoffs to consider when executing a trade. Attempting to sell quickly will usually increase the transactions costs and may have an unfavorable impact on the selling price. Taking more time to sell can increase the exposure to exogenous and unfavorable price changes. A trader should recognize the tradeoff and identify a set of efficient trading strategies that produce the minimum remaining risk exposure at any given point in time, for any given expected cost. The trader should choose the strategy that best fits his risk aversion. A more (less) risk averse trader would choose a strategy that executes more (less) quickly. A more (less) quick execution will reduce (increase) price uncertainty with higher (lower) transactions costs.

Liquidity at Risk

LO 52.6: Describe liquidity at risk (LaR) and compare it to LVaR and VaR, describe the factors that affect future cash flows, and explain challenges in estimating and modeling LaR.

Liquidity at risk (LaR) is also known as **cash flow at risk** (CFaR) and is the maximum likely cash outflow over the horizon period at a specified confidence level. A positive (negative) value for LaR means the worst outcome will be associated with an outflow (inflow) of cash. LaR is similar in concept to VaR, but instead of a change in value, it deals with a cash flow. LaR is also distinct from liquidity-related losses, but they are related.

As an example, an investor has a large market risk position that is hedged with a futures position. If the hedge is a good one, the basis risk is small, and the VaR should be small. There is the possibility of margin calls on the futures position, however, and this means there is the possibility of a cash outflow equal to the size of that position. In summary, the hedged position has a small VaR but a large LaR. At the other extreme, European options have zero LaR until expiration, but potentially large VaR prior to maturity.

The following is a list of factors that influence cash flows and LaR:

- Borrowing or lending.
- Margin requirements on market risk positions that are subject to daily marking to market.
- Collateral obligations, such as those on swaps, which can generate inflows or outflows of cash from changes in market factors, such as interest rates.

2. Jarrow, R.A. and A. Subramanian. (1997). "Mopping up liquidity." *Risk* 10 (December): 170–173.

- Short explicit options or implicit options (e.g., convertibility and call features).
- Changes in risk management policy (e.g., a change in the type of hedge), which may change mark-to-market requirements.

Two other considerations are as follows: (1) LaR can increase when the firm is facing hard times (e.g., a credit downgrade increases the rate on bank loans); and (2) there are positions that are similar in terms of market risk (e.g., a futures versus an options hedge), but are very different in terms of LaR.

As a practical matter for the firm attempting to estimate LaR, consider using the firm's VaR procedures to estimate the VaRs of marginable securities and then combine this LaR estimate with comparable figures from other sources of liquidity risk within the organization to produce an integrated measure of firm-wide liquidity risk. The point is to use the existing and accepted VaR procedures to estimate liquidity risks. It is obviously ad hoc, however, and a firm facing complex liquidity risks should build a more appropriate model. This would involve identifying and modeling the variables indicated in the following list:

- The certain cash flows (e.g., from U.S. Treasury investments).
- The unconditional uncertain cash flows (e.g., from risky bonds).
- The conditional uncertain cash flows (e.g., those that only result if a certain decision is made, such as making an investment).
- Other conditioning variables that might trigger cash flows.

Having identified the factors, the manager can construct an appropriate engine to estimate the risks. Estimating the LaR may only require a variance-covariance approach, or it may require a more advanced simulation approach.

Role of Liquidity During Crisis

LO 52.7: Describe approaches to estimate liquidity risk during crisis situations and challenges which can arise during this process.

In a crisis, assumptions concerning the level of liquidity and other properties that are reasonable in a "normal" market may not hold. Such crises have occurred in 1987, 1992, 1998, and 2007–2009. Some event usually precipitates the crisis, such as a large fall in some asset prices, which leads to lower demand and wider bid-ask spreads. The time needed for selling orders to be executed increases. Market liquidity falls at the very time the market needs it.

Many things change during the course of a crisis, and a researcher needs a model that takes into account the distinctive features of a crisis (e.g., large losses, high bid-ask spreads). **CrashMetrics** may be one way to address this. As an example, the following is the profit/loss on a derivative position based on a **delta-gamma approximation**:

$$\Pi = \delta \Delta S + \frac{\gamma}{2}(\Delta S)^2$$

where:
ΔS = change in the stock price

Taking the derivative of this measure with respect to ΔS and solving for ΔS gives the change that produces the maximum loss: $\Delta S = -\delta/\gamma$, and that maximum loss in absolute value terms is:

$$\max(\text{loss}) = -\min(\Pi) = \frac{\delta^2}{2\gamma}$$

For a derivative position that requires margin and mark-to-market, letting *m* equal the margin requirement, the worst-case cash outflow is simply *m* times this amount: $m \times \delta^2/(2\gamma)$. This approximation can be more precise with the inclusion of the effects of other Greeks (e.g., thetas), counterparty risk, and other factors.

Another method for examining the liquidity consequences associated with worst-case scenarios is to apply the basic procedure above to an extreme-value method estimated with expected shortfall (ES). The cash flow would then be m × ES.

These two variations of estimating the worst-case cash flow do not address many real-world complications. A researcher might also wish to address the complications with simulations designed for specific complications. Those complications include:

- The discreteness of credit events.
- The interdependency of credit events.
- The interaction of credit and market risk factors.
- Complications arising from the use of credit-enhancement methods, such as netting arrangements, periodic settlement, credit derivatives, credit guarantees, and credit triggers.

Crisis-scenario analysis is an alternative to the probabilistic approaches described previously. This would involve analyzing the potential problems of a particular event (e.g., the failure of a major institution) and working through the specific details of how this might occur. This has the advantage of working through scenarios at a chosen level of detail and accounting for complications and interactions. The problem is that there will be a lot of subjectivity, and the results will depend heavily on the assumptions used.

Key Concepts

LO 52.1

Liquidity risk is the degree to which a trader cannot trade a position without excess cost, risk, or inconvenience. Liquidity depends on factors such as the number of traders in the market, the frequency and size of trades, the time it takes to carry out a trade, the cost, and the risk of the transaction not being completed. It also depends on the type of asset and the degree to which the asset is standardized.

A wider (narrower) bid-ask spread indicates lower (higher) liquidity. If an asset becomes less liquid, the spread increases, and the costs of trading the asset increase.

LO 52.2

Exogenous liquidity refers to the bid-ask spread not being affected by the individual trades made by investors. This is more likely to be the case when the trades are relatively small.

Endogenous liquidity refers to when a given trade can influence the liquidity risk of the trade (i.e., a trader submitting a buy or sell order that increases the spread).

LO 52.3

The main challenge in estimating liquidity is finding the best method. One approach is finding adjustments to add on to the basic VaR. The researcher must understand how the inputs affect the "add-ons" and, if there are more than one, how the add-ons interact.

LO 52.4

The constant spread approach assumes the bid-ask spread is constant and the liquidity cost is simply, LC = 0.5 × spread × V, which can be added into the VaR formula.

$$\text{VaR} = [1 - \exp(\mu - \sigma \times z_\alpha)] \times V$$

$$\text{LVaR} = \text{VaR} + \text{LC} = [1 - \exp(\mu - \sigma \times z_\alpha) + 0.5 \times \text{spread}] \times V$$

LO 52.5

To account for endogeneity, a trader may estimate the elasticity of the price to the proportion of the market in a given large trade, denoted *E*, the proportion itself, denoted ΔN/N, and adjust the VaR formula.

$$\text{LVaR} = \text{VaR} \times \left(1 - \frac{\Delta P}{P}\right) = \text{VaR} \times \left(1 - E \times \frac{\Delta N}{N}\right)$$

LO 52.6

Liquidity at risk (LaR) is also known as cash flow at risk (CFaR) and is the maximum likely cash outflow over the horizon period at a specified confidence level.

LaR can be very different from the VaR of the same position. For example, a bond hedged with a futures contract has low VaR but high LaR from the possible margin call on the futures contract.

Factors that affect future cash flows are: borrowing or lending, margin requirements, collateral obligations, options positions, and changes in risk management policy.

LO 52.7

Many things change during the course of a crisis, and a researcher needs a model that takes into account the distinctive features of a crisis (e.g., large losses, high bid-ask spreads).

Concept Checkers

1. Suppose that portfolio XYZ has a \$1,000,000 portfolio invested in a stock that has a daily standard deviation of 2%. The current bid-ask spread of that stock is 1%. Assuming a constant spread, what is the liquidity-adjusted VaR (normal VaR) at the 95% confidence level?
   A. \$5,000.
   B. \$38,000.
   C. \$44,200.
   D. \$43,000.

2. Which of the following actions would most likely increase liquidity risk?
   A. A rapid execution of orders.
   B. A higher level of standardization of the asset.
   C. An increase in the number of traders and a decrease in the size of those trades.
   D. A decrease in the number of traders and an increase in the size of those trades.

3. When a given trade can influence the liquidity risk of a trade, this type of liquidity is known as:
   A. exogenous liquidity.
   B. undefined liquidity.
   C. endogenous liquidity.
   D. operational liquidity.

4. Assuming the following parameters: $\mu = 0$, $\sigma = 0.006$, spread = 0.01, and a 95% confidence level, the ratio of LVaR to VaR is closest to:
   A. 1.08.
   B. 1.51.
   C. 1.66.
   D. 2.04.

5. A trader has a position worth 5% of the size of the market (i.e., $\Delta N/N = 0.05$) and estimates that the elasticity of price to size of trade is: $E = -0.2$. The ratio of LVaR to VaR based only on endogenous factors is closest to:
   A. 0.99.
   B. 1.01.
   C. 1.05.
   D. 1.40.

Concept Checker Answers

1. **B** LVaR = (1,000,000 × 1.65 × 0.02) + (0.5 × 1,000,000 × 0.01) = $38,000

2. **D** Larger and fewer traders will ultimately lower liquidity and increase liquidity risk.

3. **C** It is "endogenous" because it is determined by the trading activity itself.

4. **B** $$\frac{\text{LVaR}}{\text{VaR}} = 1 + \frac{0.01}{2 \times [1 - \exp(-0.006 \times 1.65)]} = 1.508$$

5. **B** $\Delta P/P = E \times \Delta N/N = -0.2 \times 0.05 = -0.01$

$$\left.\frac{\text{LVaR}}{\text{VaR}}\right|_{\text{endogenous}} = 1 - (-0.01) = 1.01$$

The following is a review of the Operational and Integrated Risk Management principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

Assessing the Quality of Risk Measures

Topic 53

Exam Focus

This topic focuses primarily on model risk and model errors, with specific criticisms of the value at risk (VaR) model. It is important to understand model risk and the factors that could result in variability in VaR estimates. It is also important to understand the challenges associated with mapping risk factors to positions in making VaR calculations. Be ready to explain how incorrect mapping factors can understate certain risks including reputational, liquidity, market, and basis risk. The second part of this topic focuses on two specific case studies on the failures in strategies during 2005 and 2007–2009 related to modeling errors and the underestimation of key risks.

Model Risk

LO 53.1: Describe ways that errors can be introduced into models.

Models are highly useful in simulating real-life scenarios; however, they can suffer from several risks. **Model risk** is the risk of incorrect trading or risk management decisions due to errors in models and model applications, which can lead to trading losses and give rise to legal, reputational, accounting, and regulatory risk. Biases in models themselves do not necessarily cause model risk; however, inaccurate or inappropriate inputs can create distortions in the model.

There are several ways in which errors can be introduced into models. These include bugs in the programming of model algorithms, securities valuations or hedging, variability of value at risk (VaR) estimates, or inaccurate mapping of positions to risk factors.

For example, bugs in programming occurred in May 2008 when Moody's used flawed programming to incorrectly assign AAA ratings to certain structured credit products. It happened again in October 2011 when bugs in the quant programming used by AXA Rosenberg[1] led to investor losses. For Moody's, model risk was related to reputational and liquidity risk because the model errors had been discovered prior to being made public and coincided with a change in ratings methodology that resulted in no change to the ratings of certain products. As a result, Moody's was suspected of tailoring its model to the desired ratings, which damaged the company's reputation. For AXA Rosenberg, the discovery of the model error had not been made public in a timely manner, leading to both regulatory fines and considerable reputational damage to the firm.

1. AXA Rosenberg Group, LLC is a division of the French insurance company AXA.

Model errors in securities valuations or in hedging can create losses within a firm and lead to market risk and operational risk. *Market risk* is the risk of buying overvalued (or, at a minimum, fairly valued) securities in the market that are thought to be undervalued. *Operational risk* is the risk of recording unprofitable trades as profitable.

Relying on market prices rather than model prices through marking positions to market can theoretically avoid model errors and reduce valuation risk. A problem with this approach, however, is that certain positions, including long-term bank commercial loans, are difficult to mark-to-market due to infrequent trading and complexities in valuation.

Variability of VaR Estimates

LO 53.2: Explain how model risk and variability can arise through the implementation of VaR models and the mapping of risk factors to portfolio positions.

Risk management is typically implemented via computer systems that help to automate gathering data, making computations, and generating reports. These systems can be made available commercially, and are typically used by smaller firms, while larger firms tend to use their own in-house systems, often in combination with commercial models. The implementation process for computing risk is usually referred to as the firm's *VaR model*, although the general computation process can apply to any risk measure other than VaR.

Data preparation is crucial in risk measurement systems. There are three types of data involved:

1. *Market data* is time series data (usually asset prices) that is used in forecasting the distribution of future portfolio returns. Market data involves obtaining the time series data, removing erroneous data points, and establishing processes for missing data. All of these steps can be costly but necessary.

2. *Security master data* is descriptive data on securities, including maturity dates, currency, and number of units. Building and maintaining data for certain securities, including equities and debt, can be challenging; however, it is critical from a credit risk management perspective.

3. *Position data* matches the firm's books and records but presents challenges as data must be collected from a variety of trading systems and across different locations.

Once the data is collected, software is used to compute the risk measures using specific formulas, which are then combined with the data. Results are then published in documents for reporting by managers. All of these steps can be performed in numerous ways and can lead to several issues within the risk measurement system. We focus on two of these issues: the variability of the resulting measures and the appropriate use of data.

Variability in risk measures, including VaR, is both a benefit and a problem. Managers have significant discretion and flexibility in computing VaR, and parameters can be freely used in

many different ways. This freedom in measuring VaR leads to two significant problems in practice:

1. *Lack of standardization of VaR parameters*. Given the variability in VaR measurements and managers' discretion, parameters including confidence intervals and time horizons can vary considerably, leading to different measurements of VaR.

2. *Differences in VaR measurements*. Even if VaR parameters were standardized, differences in measuring VaR could lead to different results. These include differences in the length of the time series used, techniques for estimating moments, mapping techniques (discussed in the next section) and the choice of risk factors, decay factors in using exponentially weighted moving average (EWMA) calculations, and the number of simulations in Monte Carlo analysis.

Varying parameters can lead to materially different VaR results. For example, one study using different combinations of parameters, all within standard practice, of portfolios consisting of Treasury bonds and S&P 500 index options indicated that VaR results differed considerably by a factor of six or seven times. A simple read of the different VaR models published in the annual reports of some of the larger banks can give an indication of the variability in their measurements.

Risk Factor Mapping for VaR Calculations

Mapping refers to the assignment of risk factors to positions. Mapping choices can also impact VaR results. These could include practical choices among alternatives where each alternative has its benefits and disadvantages. For example, managers have a choice between cash flow mapping and duration-convexity mapping for fixed income securities. *Cash flow mapping* leads to greater accuracy (each cash flow is mapped to a fixed income security with an approximately equal discount factor); however, *duration-convexity mapping* requires fewer and less complex computations, reducing costs and potential data errors as well as model risks.

It may also be difficult to locate data that addresses specific risk factors. One example is the previously widespread practice of mapping residential mortgage-backed securities (RMBS) or other securitized products to corporate credit spreads of the same rating. Because data on securitization spreads is typically not widely available, using a proxy risk factor of generic corporate bond spreads can be misleading, especially since previously lower spreads on securitizations widened considerably more during the recent financial crisis than did corporate spreads. This is an example of model risk and the inefficiency of VaR estimates in modeling large movements in market prices.

Incorrect mapping to risk factors can create risks such as liquidity risk and basis risk. **Liquidity risk** arises from divergences in model and market prices. For example, convertible bonds can be mapped to risk factors including implied volatilities, interest rates, and credit spreads based on the theoretical (model) price of the convertible bond using a replicating portfolio. However, significant divergences in model and market prices are difficult to capture with market data, and as a result, VaR estimates based on the replicating portfolio can considerably understate risk, creating liquidity risk.

Basis risk is the risk that a hedge does not provide the required or expected protection. Basis risk arises when a position or its hedge is mapped to the same set of risk factors, which can be done when it is difficult to distinguish between two closely related positions. While this results in a measured VaR of zero, the positions have significant basis risk. Basis risk is also present in the risk modeling of securitization exposures where securitizations are hedged with corporate credit default swap (CDS) indices of similar ratings.

Other strategies can also lead to misleading VaR estimates. For example, **event-driven strategies** have outcomes that are close to binary and depend on a specific event occurring, including mergers or acquisitions, bankruptcy, or lawsuits. For these trades, the range of results cannot be measured based on historical return data. **Dynamic strategies** are another example, where risk is generated over time rather than at a specific point in time.

Credit Market in Early 2005

LO 53.3: Identify reasons for the failure of the long-equity tranche, short-mezzanine credit trade in 2005 and describe how such modeling errors could have been avoided.

Credit Trade Description and Modeling Issues

Volatility in credit markets in the spring of 2005 caused significant modeling errors from both misinterpretation and incorrect application of models. Trades incurred losses as only certain dimensions of risks were hedged, while others were ignored.

A popular strategy in credit markets for hedge funds, banks, and brokerages was to sell protection on the equity tranche and buy protection on the junior (mezzanine) tranche of the CDX.NA.IG index, the investment-grade CDS index. As a result, the trade was long credit and credit spread risk on the equity tranche and short credit and credit spread risk on the mezzanine tranche. The trade was primarily executed on the IG3 and IG4 index series. The trade was designed to be default-risk neutral at initiation with equal credit spread sensitivities on the two legs. The motivation of the trade was to have a positively convex payoff profile with the two positions benefiting from credit spread volatility, while earning a positive net spread on the positions (positive carry). This allowed trades to have a position similar to delta-hedged, long option portfolios by receiving, rather than paying, time value.

The hedge ratio for the delta-hedged portfolio then determined the dollar amount of the mezzanine to be shorted for every dollar of the long equity. In other words, the hedge ratio was the ratio of the profit and loss impact of a 1 bp widening of the CDX index on the equity and mezzanine tranches. The proper hedge ratio then allowed for the creation of a portfolio based on the CDX index that, at the margin, was default-risk neutral. The CDX trade benefited from a large change in credit spreads and essentially behaved like an option straddle on credit spreads with an option premium paid to the owner of the option. The hedge ratio for the CDX index was around 1.5 to 2 in early 2005, which resulted in a net flow of spread income to the long equity/short mezzanine trade.

The critical error in the trade, however, was that it was set up at a specific value of implied correlation. A static correlation was considered a critical flaw as the deltas that were used in setting up the trade were partial derivatives that ignored any changes in correlation. With changes in credit markets, changing correlations doubled the hedge ratio to close to 4 by the summer of 2005. As a result, traders now needed to sell protection on nearly twice the notional value of the mezzanine tranche to maintain portfolio neutrality. Stated differently, as long as correlations remained static, the trade remained profitable. However, once correlations declined and spreads did not widen sufficiently, the trade became unprofitable.

Therefore, while the model did not ignore correlation, it assumed a static correlation and instead focused on anticipated gains from convexity. The error could have been corrected by stress testing correlation or by employing an overlay hedge of going long, single-name protection in high default-probability names.

Credit Market Example

Problems in credit markets were already evident by the spring of 2005. The problems were largely related to the automobile industry, specifically the original equipment manufacturers (OEMs), including Ford, Chrysler, and General Motors (GM), which had been experiencing troubles for some time. OEMs were particularly important in the U.S. investment-grade bond market, and the emerging threat of a downgrade to junk status rattled markets. Although the OEMs were not directly part of the CDX.NA.IG index, several of their related finance companies were. Outside of OEMs, several auto parts manufacturers were included in two series of the index, the IG3 and IG4 indices.

The immediate priority of the OEMs in early 2005 was to secure a relief from the United Auto Workers (UAW) union of health benefit commitments to retirees. When GM and the UAW were unable to reach an agreement in the spring of 2005, which coincided with the announcement of large losses for GM, GM and Ford were downgraded to junk status by S&P and Moody's. This created a sharp widening of corporate spreads, including the spreads on the automotive finance companies and other industry names. Several auto parts manufacturers filed for Chapter 11 bankruptcy protection. As a result, the market was now anticipating the possibility of defaults in the IG3 and IG4 indices, and the probability of extreme losses became real. In addition, the convertible bond market was also experiencing a selloff that resulted in widening of spreads. The IG indices widened in line with the credit spread widening of the index constituents. The mark-to-market value and the implied correlation of the equity tranche dropped sharply. The implied correlation fell given that (1) the auto parts supplier bankruptcies were in the IG4 series, which led to close to 10% of the portfolio now close to default, and (2) the widening of the IG4 series was constrained by hedging, which led to a fall in correlation. Participants could hedge short credit positions in the equity tranche by selling credit protection on the mezzanine tranche or the IG4 index series. Concurrently, the mezzanine tranche saw a small widening as market participants were covering their positions by selling protection on the mezzanine tranche (that is, they were taking on credit risk). These events led to the unwinding of the equity/mezzanine tranche trade with the relative value trade experiencing large losses.

Risk Underestimation in 2007–2009

LO 53.4: Explain major defects in model assumptions that led to the underestimation of systematic risk for residential mortgage backed securities (RMBS) during the 2007–2009 financial downturn.

The subprime RMBS valuation and risk models have been widely employed by credit rating agencies to assign bond ratings, by traders and investors in bond valuations, and by issuers in structuring RMBS. During the 2007–2009 financial downturn, two major defects in model assumptions became apparent:

1. *Assumption of future house price appreciation.* The RMBS risk model generally assumed that future house prices would rise, or at least not fall, based on relatively few historical data points. When house prices actually did drop beginning in 2007, this incorrect assumption led to a significant underestimation of the potential default rates and systematic risk in RMBS because the credit quality of the loans was dependent on borrowers' ability to refinance without additional equity.

2. *Assumption of low correlations.* The RMBS model assumed low correlations among regional housing markets, implying that loan pools from different geographical regions were well diversified. When house prices declined, correlations increased and loan defaults were much higher than previously expected under the model stress scenarios.

These two model errors led to a significant underestimation of systematic risk in subprime RMBS returns. When mortgage default rates began to increase, rating agencies were required to downgrade most issues, and by the end of 2009, approximately 45% of the initially AAA-rated U.S. RMBS had been downgraded. The downgrades of RMBS from their AAA-equivalent ratings shocked markets and exposed the degree to which systemic risk had been underestimated and mispriced.

There have been several explanations proposed for the inaccuracy of the rating models. First, the compensation of rating agencies by bond issuers led to a potential conflict of interest scenario that resulted in lower ratings standards. Second, an increase in demand for higher rated bonds with a modestly higher yield resulted in searching for yield. Finally, mapping problems led to misleading risk measurement results, as highly rated securitized products were frequently mapped to highly rated corporate bond spread indices. This resulted in incorrect VaR estimates, as incorrect mappings indicated it would be unlikely that bonds would decline significantly in value. In reality, the most highly rated RMBS lost a significant portion of their value, declining close to 70% during the subprime crisis, while lower investment-grade RMBS lost virtually all of their value.

Key Concepts

LO 53.1

Model risk is the risk of incorrect trading or risk management decisions due to errors in models and model applications, which can lead to trading losses and potential legal, reputational, accounting, liquidity, and regulatory risk. Errors can be introduced into models through programming bugs, securities valuations or hedging, VaR estimates, and position mappings.

LO 53.2

Firms use software to compute the risk measures from the data collected using specific formulas, which can be performed in a variety of ways and lead to potential issues. Variability in risk measures, including lack of uniformity in the use of confidence intervals and time horizons, can lead to variability in VaR estimates. Other factors can also cause variability, including length of time series, ways of estimating moments, mapping techniques, decay factors, and number of simulations.

Mapping refers to the assignment of risk factors to positions, and mapping choices can considerably impact VaR results.

Cash flow mapping results in greater accuracy of estimates. Duration-convexity mapping requires fewer risk factors and less complex computations, which reduces costs, data errors, and model risks. Locating data that addresses specific risk factors may also be difficult.

Liquidity risk arises from large divergences in model and market prices that are difficult to capture with market data, and as a result, VaR estimates based on replicating portfolios can understate risk and create liquidity risk.

Basis risk is the risk that a hedge does not provide the required or expected protection. Basis risk arises when a position or its hedge is mapped to the same set of risk factors.

LO 53.3

Volatility in credit markets in the spring of 2005 fueled by company bankruptcies and losses led to defaults in the IG3 and IG4 index series of the CDX.NA.IG index, causing large selloffs that resulted in widening spreads. This also resulted in modeling errors from both misinterpretation and incorrect application of models, which led to trade losses.

LO 53.4

Two significant model errors in the RMBS valuation and risk models led to a significant underestimation of systematic risk in subprime RMBS returns during 2007–2009. First, the RMBS risk model assumed future house prices to rise or at least stay flat. The eventual decline in house prices starting in 2007 led to a significant underestimation of the potential default rates and systematic risk in RMBS. Second, the RMBS model assumed low correlations among regional housing markets. When house prices declined, correlations and loan defaults increased.

Concept Checkers

1. Due to a recently discovered error in its valuation model, Samuelson, Inc. had previously recorded certain trades as profitable even though the positions were unprofitable. The risk that best characterizes this error is:
   A. operational risk.
   B. liquidity risk.
   C. market risk.
   D. hedge risk.

2. Duane Danning is a junior risk analyst at a large risk management firm. He has been asked to assess the firm's risk modeling practices and evaluate potential ways in which errors could be introduced into models. In his analysis, Danning indicates that errors can be introduced into models through programming bugs and errors in VaR estimates but rarely through incorrect position mappings. Danning's analysis is most accurate with regard to:
   A. only programming bugs and incorrect position mappings.
   B. only programming bugs and errors in VaR estimates.
   C. only errors in VaR estimates.
   D. only incorrect position mappings.

3. An advantage of duration mapping over cash flow mapping is that duration mapping:
   A. is more accurate than cash flow mapping, thus reducing mapping errors.
   B. uses cash flows that are mapped to specific fixed income securities without the use of approximations.
   C. uses more complex computations, thus reducing data errors and model risk.
   D. uses fewer risk factors, thus reducing data errors and model risk.

4. A common trade during 2004 and 2005 was to sell protection on the equity tranche and buy protection of the mezzanine tranche of the CDX.NA.IG index. Which of the following statements regarding this trade is least accurate?
   A. The trade was set up to be default-risk neutral at initiation.
   B. The trade was short credit spread risk on the equity tranche and long credit spread risk on the mezzanine tranche.
   C. The main motivation for the trade was to achieve a positively convex payoff profile.
   D. The trade was designed to benefit from credit spread volatilities.

5. Which of the following two model errors in the RMBS valuation and risk models are considered to have contributed the most to a significant underestimation of systematic risk in subprime RMBS returns during 2007–2009?
   A. The assumption of future house price appreciation and the assumption of high correlations among regional housing markets.
   B. The assumption of future house price declines and the assumption of high correlations among regional housing markets.
   C. The assumption of future house price appreciation and the assumption of low correlations among regional housing markets.
   D. The assumption of future house price declines and the assumption of low correlations among regional housing markets.

Concept Checker Answers

1. **A** Recording trades as profitable that have, in fact, lost money is an example of operational risk.

2. **B** Danning's analysis is most accurate with regard to only programming bugs and errors in VaR estimates. Incorrect position mappings can also lead to material errors in risk models.

3. **D** Duration mapping (or duration-convexity mapping) requires the use of fewer risk factors and less complex computations, thus reducing costs, data errors, and model risks. Cash flow mapping results in greater accuracy of estimates, however, because cash flows are mapped to specific fixed income securities without the use of approximations.

4. **B** The trade was long credit and credit spread risk on the equity tranche and *short* credit and credit spread risk on the mezzanine tranche. The other statements are accurate.

5. **C** The two model errors considered to have contributed the *most* to a significant underestimation of systematic risk were (1) the assumption of future house price appreciation, and (2) the assumption of low correlations among regional housing markets.

The following is a review of the Operational and Integrated Risk Management principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

Liquidity and Leverage

Topic 54

Exam Focus

This topic analyzes the effects of liquidity and leverage on firm risk. For the exam, understand the distinction between transactions liquidity and funding liquidity, and the role banks play in providing liquidity. Also, be able to calculate a firm's leverage ratio and the leverage effect, and know how to construct the economic balance sheet given trades such as buying stock on margin, selling stock short, and taking positions in derivatives. Finally, be able to explain tightness, depth, and resiliency as they relate to liquidity risk.

Sources of Liquidity Risk

LO 54.1: Differentiate between sources of liquidity risk, including balance sheet/funding liquidity risk, systematic funding liquidity risk, and transactions liquidity risk, and explain how each of these risks can arise for financial institutions.

LO 54.9: Explain interactions between different types of liquidity risk and explain how liquidity risk events can increase systemic risk.

Liquidity is defined in many ways in financial markets. In general, an asset is liquid if it is "close to cash." This means that the asset can be sold quickly, cheaply, and without moving the price "too much." A market is liquid if positions can be unwound quickly, cheaply (i.e., at low transactions costs), and without undue price deterioration.

Liquidity has two essential properties, which relate to two essential forms of risk. **Transactions liquidity** deals with financial assets and financial markets. **Funding liquidity** is related to an individual's or firm's creditworthiness. Risks associated with liquidity include:

- **Transactions** (or **market**) **liquidity risk** is the risk that the act of buying or selling an asset will result in an adverse price move.
- **Funding liquidity risk** or **balance sheet risk** results when a borrower's credit position is either deteriorating or is perceived by market participants to be deteriorating. It also occurs when the market as a whole deteriorates. Under these conditions, creditors may withdraw credit or change the terms of credit (e.g., increase the required collateral for the loan). The position may, as a result, be unprofitable or may need to be unwound. Balance sheet risks are higher when borrowers fund longer term assets with shorter term liabilities. This is called a **maturity mismatch**. Maturity mismatching is often profitable for firms because short-term investors bear less risk and have a lower required rate of return. This means that short-term debt financing contributes less to the overall cost of capital of a borrowing firm. The incentive to maturity mismatch is even greater when the yield curve is upward sloping. However, funding long-term assets with short-term

financing exposes the borrower to **rollover risk** (sometimes called cliff risk), the risk that the debt cannot be refinanced or can only be refinanced at escalating rates.
- **Systemic risk** is the risk that the overall financial system is impaired due to severe financial stress. With this risk, credit allocation is impaired across the financial system.

Risks associated with liquidity are interrelated and can exacerbate problems. For example, if collateral requirements are increased, a counterparty may be forced to unwind a position early and at a potential loss. In this case, the increase in funding liquidity risk increases the transactions liquidity risk.

An important connection between funding and transactions liquidity is leverage. An investor with a long position may be forced to sell an asset if future funding for the asset dries up. This in turn would reduce the number of potential asset holders, leading to a reduction in asset valuation. It may be the case that this decline in price is temporary, however, the length of the depressed asset price could be long enough to adversely impact the solvency of the investor who initially purchased the asset. A rapid deleveraging of assets could lead to a "debt-deflation crisis."

Transactions liquidity could also impair funding liquidity. For example, if a hedge fund is facing redemptions, it is forced to raise cash by selling assets and therefore must decide which assets to sell first. Selling highly liquid assets will lead to fewer adverse price impacts, but will leave the hedge fund with a more illiquid portfolio. On the other hand, selling highly illiquid assets will increase realized losses, which may put additional pressure on the portfolio from a funding liquidity standpoint.

The level of economy-wide liquidity directly impacts the level of systemic risk. When market conditions deteriorate, liquidity tends to become constrained just when investors need it the most. Liquidity risk events could potentially become systemic risk events through disruptions in payment, clearing, and settlement systems. Severe stress to the financial system would impact market participants simultaneously, suggesting that the illiquidity or insolvency of one counterparty may have a domino effect on other market participants throughout the system.

Liquidity Transformation by Banks

LO 54.2: Summarize the asset-liability management process at a fractional reserve bank, including the process of liquidity transformation.

Commercial bank assets are typically longer-term and less liquid than bank liabilities (e.g., deposits). Wholesale funding (i.e., non-deposit sources of funding like commercial paper, bonds, and so on) is generally longer term but deposits are "sticky." Depositors generally change banks only if impelled to by a move or some other extenuating circumstance. Deposits make up approximately 60% of bank liabilities in the United States.

Banks only expect a fraction of deposits and other liabilities to be redeemed at any point in time. As a result, they do not hold all the deposits in liquid assets, but make loans with deposits instead. For example, a bank might take in \$100 of deposits, hold \$10 for redemptions, and lend the remaining \$90. This is known as a **fractional-reserve bank** and the process of using deposits to finance loans is known as **asset-liability management** (ALM).

The bulk of banks in history have been fractional-reserve banks. The alternative to a fractional-reserve system is one in which the bank uses owners' money (i.e., equity) or money raised in capital markets to make loans, and keeps in reserve cash or highly liquid assets equal to its deposits.

If withdrawals are greater than the bank's reserves, the bank is forced into a **suspension of convertibility**. This means the bank will not be able to, as expected by depositors, convert deposits immediately into cash. In the extreme, there may even be a **run on the bank**. In the case of a bank run, depositors who are concerned about bank liquidity may attempt to get money out of the bank before other depositors and lenders. While rollover risk associated with other short-term financing is less extreme than bank runs, it does increase the fragility of banks. Higher capital reduces bank fragility.

Frozen commercial paper markets in the wake of the Lehman Brothers failure illustrated the fragility of bank funding. Commercial funding couldn't be placed and thus fell dramatically after the Lehman bankruptcy. It became nearly impossible to roll over longer term paper and very short-term paper rose to account for approximately 90% of the market. The Federal Reserve stepped in after the Lehman bankruptcy and created the Commercial Paper Funding Facility (CPFF) and the Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility (AMLF).

Structured Credit Products and Off-Balance Sheet Vehicles

Structured credit products, such as asset-based securities (ABSs) and mortgage-backed securities (MBSs), match investor funding needs with pooled assets. Because these products are maturity matched, they are not subject to funding liquidity issues. However, investor financing for structured credit products can create liquidity risk when investors rely on short-term financing. This type of financing was one of the main drivers of the recent subprime crisis and the increase in leverage in the financial system leading up to the crisis. Two types of short-term financing include: (1) securities leading (i.e., applying structured credit products as collateral to short-term loans), and (2) off-balance sheet vehicles.

Special-purpose vehicles (SPVs) serve as off-balance sheet vehicles by issuing secured debt in the form of asset-backed commercial paper (ABCP). **ABCP conduits** finance purchases of assets, such as securities and loans, with ABCP. They receive liquidity and credit support via credit guarantees. **Structured investment vehicles** (SIVs) differ slightly from ABCP conduits because they do not receive full liquidity and credit support.

Prior to the subprime crisis, both ABCP conduits and SIVs profited from the spread between funding costs and asset yields. The assets held by these vehicles typically had longer maturities than the ABCP that fund the assets. In addition to maturity transformation, these vehicles also provided liquidity transformation. This was accomplished by creating ABCP that was more liquid and had shorter terms than the assets held in the conduit and SIV. However, despite being off-balance sheet, which permitted firms to hold less capital, these vehicles did not entirely transfer risk. As a result, they still contributed to the leverage issues and fragility of the financial system during the recent subprime crisis.

Systematic Funding Liquidity Risk

LO 54.3: Describe specific liquidity challenges faced by money market mutual funds and by hedge funds, particularly in stress situations.

Systematic funding risks were apparent in many market sectors during the subprime mortgage crisis. As loans become shorter term, lenders and borrowers are exposed to greater liquidity risks. Borrowers must be able to refinance in order to repay short-term loans. The risk is systematic in that it affects borrowers and lenders at the same time.

Liquidity issues arose during the recent financial crisis for a variety of investment strategies including:

- **Leveraged buyouts** (LBOs). Leveraged loans became the dominate type of syndicated bank loans as LBOs and private equity grew before the crisis. Leveraged loans accounted for a large part of collateralized loan obligations (CLOs) and collateralized debt obligations (CDOs), which provided funding for LBOs. During the subprime mortgage crisis, LBO deals fell apart as funding dried up. Some loans, called "hung loans," had not been distributed to investors and demand dried up. Banks incurred significant losses as prices fell sharply.
- **Merger arbitrage hedge funds**. Hedge funds engaged in merger arbitrage experienced losses in the early stages of the subprime mortgage crisis. After a merger is announced, the target's stock price typically increases and the acquirer's price sometimes declines due to increased debt. The merger arbitrage strategy exploits the difference between the current and announced acquisition prices. Hedge funds experienced large losses as mergers were abandoned when financing dried up.
- **Convertible arbitrage hedge funds**. Convertible arbitrage strategies rely on leverage to enhance returns. Credit is extended by broker-dealers. When financing becomes unavailable due to market conditions, as experienced in the 2007–2009 financial crisis, convertible bond values drop precipitously. The funding liquidity problem was compounded by redemptions (i.e., a market liquidity problem). Also, because there is a limited clientele investing in convertible bonds, when the clientele develops a dislike for the product due to deteriorating market conditions, it is difficult to sell the assets without large price declines. The gap between convertible bond prices and replicating portfolios widened dramatically during the financial crisis, but it still did not bring arbitrage capital into the market.

The broader point is that investment strategies, such as merger arbitrage, convertible arbitrage, and leveraged buyouts, are not only exposed to idiosyncratic risks, but also to systematic risks (i.e., systematic funding risks in this case). The risks are soft risks because they are difficult to relate to a particular series of asset returns. Instead, analysts must examine data on credit and liquidity spreads as well as quantitative and anecdotal data on the availability of credit in the market to understand the probability of a liquidity freeze.

Money market mutual fund (MMMF) investors can write checks and make electronic bank transfers. Like banks, MMMFs are obligated to repay investors/depositors on demand. In general, underlying MMMF assets are high credit quality instruments with short maturities (e.g., a few weeks to a few months). However, the values of the underlying assets in the fund, despite their relative safety, are subject to change. As such, redemptions may be limited if asset values fall. The liabilities of MMMFs are, therefore, more liquid than their investments, similar to banks.

MMMFs use a form of accounting called the amortized cost method, under the Securities and Exchange Commission's (SEC) Rule 2a – 7. This means that MMMF assets do not have to be marked-to-market each day, as required for other types of mutual funds. The reason behind the difference is that extremely short-term securities are not likely to revalue based on changes in interest rates and credit spreads. MMMFs set a notional value of each share equal to $1.00. However, credit write-downs cannot be disregarded and it is possible for net asset values (NAVs) to fall below $1.00. This is known as **breaking the buck**.

Liquidity risk can also cause NAVs to fall below $1.00. MMMFs, like depository institutions, are subject to runs. If a large proportion of investors try to redeem shares in adverse market conditions, the fund may be forced to sell money market paper at a loss. This can potentially result in write-downs and breaking the buck.

Economics of the Collateral Market

LO 54.4: Compare transactions used in the collateral market and explain risks that can arise through collateral market transactions.

Collateral markets have two important purposes. First, they enhance the ability of firms to borrow money. Cash is only one type of asset that is borrowed. Securities are also borrowed in collateral markets. Second, collateral markets make it possible to establish short positions in securities.

Firms with excess cash are more willing to lend at a low rate of interest if the loan is secured by collateral. Securities are used as collateral for secured loans. Collateralized loans can be short term or longer term. Overnight loans are often extended automatically. The full value of the securities is not lent in a collateralized loan. The difference is called a **haircut**. For example, a lender may be willing to lend $95 against $100 of collateral.

Collateral values fluctuate and most collateralized borrowing arrangements require that variation margin be paid to make up the difference (called **remargining**). Variation margin is the additional funds a broker requests so that the initial margin requirement keeps up with losses. The haircut ensures that the value of the collateral can fall by a certain percentage (i.e., 5% in the previous example) and still leave the loan fully collateralized. The variation margin protects the lender.

Collateralized loans are used to finance securities or other assets or trades. The securities pledged to one firm are often loaned or pledged again, hence the collateral circulates. This process is known as **rehypothecation** or **repledging**.

The role of collateral has expanded in contemporary finance, hand-in-hand with the development of securitization. Securitization creates securities that can be pledged as collateral for credit. Securitized assets generate cash flows, may appreciate in value, and can be used as collateral for other transactions.

Life insurance companies own large portfolios of high-quality assets. They may use these assets for collateralized loans to borrow at low rates and reinvest at higher rates. Hedge funds pledge securities to finance portfolios at rates cheaper than unsecured loans.

Markets for collateral take the following forms:

- **Margin loans**. Margin loans are used to finance security transactions. The margin loan is collateralized by the security and is often provided by the broker intermediating the trade. The broker maintains custody of the securities in a street name account (i.e., securities are registered in the name of the broker rather than the owner). This structure makes it easier to seize and sell securities to meet margin calls. An added advantage to the broker is that securities in street name accounts can be used for other purposes, such as lending to other customers for short sales. In practice, the broker uses the customer's collateral to borrow money in the money market to provide margin loans to customers. The margin loan to the broker is collateralized by the repledged customer collateral. The Federal Reserve's Regulation T sets the initial margin requirement for securities purchases at 50%. **Cross-margin agreements** are used to establish the net margin position of investors with portfolios of long and short positions. In general, cross margin involves transferring excess margin in one account to another account with insufficient margin, resulting in lower overall margin for the investor.
- **Repurchase agreements** or **repos**. Repurchase agreements, also known as repos and RPs, are another form of collateralized short-term loans. They involve the sale of a security at a forward price agreed upon today. The interest on the loan is implied from the difference between spot and forward prices of the securities. While traditionally collateral had little or no credit risk (collateral was usually Treasury bills), today acceptable collateral encompasses whole loans, high-yield bonds, and structured credit products. Repos allow banks and other firms to finance inventories of structured credit products and allow for high investment grade ratings for senior tranches of asset-backed securities (ABSs) and collateralized debt obligations (CDOs).
- **Securities lending**. Securities lending involves the loan of securities to another party in exchange for a fee, called a **rebate**. The lender of the securities continues to receive the dividends and interest cash flows from the securities. Lenders of securities are often hedge funds or other large institutional investors of equities. Securities are held in street name accounts to make them available for lending to traders who want to short stocks. Fixed income securities lending typically involves the loan of Treasury securities for cash. The cash is invested in a higher risk bonds and the investor's objective is to earn the spread between the two.
- **Total return swaps**. In a total return swap (TRS), one party pays a fixed fee in exchange for the total return (both income and capital gains) on a reference asset, typically a stock. The advantage is that the party paying the fee can earn the return from the underlying asset without owning the asset. The party providing the return (such as a hedge fund) is, in essence, short the asset.

Professor's Note: Securities lending, like repurchase agreements, are often structured as sales of securities, not loans of securities, so the holder of the collateral can rehypothecate the securities, or even sell them in a timely fashion if the loan is not repaid.

Leverage Ratio and Leverage Effect

LO 54.5: Describe the relationship between leverage and a firm's return profile, calculate the leverage ratio, and explain the leverage effect.

A firm's **leverage ratio** is equal to its assets divided by equity (total assets / equity). That is:

$$L = \frac{A}{E} = \frac{(E + D)}{E} = 1 + \frac{D}{E}$$

For an all-equity financed firm, the ratio is equal to 1.0, its lowest possible value. As debt increases, the leverage ratio (i.e., multiplier) increases. For example, a firm with $100 of assets financed with $50 debt and $50 equity has a leverage ratio equal to 2.0 ($100 / $50 = 2).

Return on equity (ROE) is higher as leverage increases, as long as the firm's return on assets (ROA) exceeds the cost of borrowing funds. This is called the **leverage effect**. The leverage effect can be expressed as:

$$r_E = Lr_A - (L - 1)r_D$$

where:
r_A = return on assets
r_E = return on equity
r_D = cost of debt
L = leverage ratio

It may help to think of this formula in words as follows:

ROE = (leverage ratio × ROA) – [(leverage ratio – 1) × cost of debt]

For a firm with a zero cost of debt, return on equity is magnified by the leverage factor; however, debt is not free. Thus, return on equity (ROE) increases with leverage, but the cost of borrowing, because there is more debt, also increases. The L – 1 factor multiplies the cost of debt by the proportion of the balance sheet financed with debt. For example, with a leverage ratio of 2, 50% of the balance sheet is financed with debt and 50% with equity. So for every $2 of assets, $1 comes from shareholders and $1 comes from borrowed funds. We multiply the cost of debt by 1 in this case. If the leverage ratio is 4, 25% is financed with equity and 75% is financed with debt. Thus, for every $4 of assets, $1 is equity and $3 is borrowed funds. In the formula, we multiply the cost of debt by 3. The higher the leverage factor, the bigger the multiplier but also the higher the debt costs. Leverage amplifies gains but also magnifies losses. That is why leverage is often referred to as a double-edged sword.

The effect of increasing leverage is expressed as:

$$\partial r_E / \partial L = r_A - r_D$$

where:
∂r_E = change in retained earnings
∂L = change in the leverage ratio

This formula implies that, given a change in the leverage ratio, ROE changes by the difference between ROA and the cost of debt.

The equity in the denominator of the leverage ratio depends on the entity. If it is a bank, it may be the book value of the firm. It might also be calculated using the market value of the firm. The net asset value (NAV) of a fund is the appropriate denominator for a hedge fund. The NAV reflects the current value of the investors' capital in the fund.

Example: Computing firm ROE (total assets = $2)

Martin, Inc., a U.S. manufacturing company, has an ROA equal to 5%, total assets equal to $2, and equity financing equal to $1. The firm's cost of debt is 2%. **Calculate** the firm's ROE.

Answer:

$$r_E = Lr_A - (L - 1)r_D$$

$$r_E = [(2 / 1) \times 5\%] - [(2 - 1) \times 2\%] = 8\%$$

Example: Computing firm ROE (total asset = $4)

Martin, Inc., a U.S. manufacturing company, has an ROA equal to 5%, total assets equal to $4, and equity financing equal to $1. The firm's cost of debt is 2%. **Calculate** the firm's ROE.

Answer:

$$r_E = Lr_A - (L - 1)r_D$$

$$r_E = [(4 / 1) \times 5\%] - [(4 - 1) \times 2\%] = 14\%$$

Given a cost of debt of 2%, increasing the leverage factor from 2 to 4 increased the firm's ROE from 8% to 14%.

Leverage is also influenced by the firm's hurdle rate (i.e., required ROE). For example, assume a firm's hurdle rate (i.e., ROE) is 10%, ROA equals 6%, and its cost of debt equals 2%. The firm will choose a leverage ratio of 2.0. That is:

$$\text{ROE} = (2 \times 6\%) - (1 \times 2\%) = 10\%$$

Explicit and Implicit Leverage

LO 54.6: Explain the impact on a firm's leverage and its balance sheet of the following transactions: purchasing long equity positions on margin, entering into short sales, and trading in derivatives.

Purchasing stock on margin or issuing bonds are examples of using leverage explicitly to increase returns. However, there are other transactions that have implicit leverage. It is important to understand the **embedded leverage** in short positions and derivatives, such as options and swaps. By constructing economic balance sheets for investors and/or firms, it is possible to measure the implicit leverage of these transactions.

Margin Loans and Leverage

First, consider margin loans. The stock purchased with the margin loan is collateral for the loan. The haircut (h) is the borrower's equity and $1 - h$ is loaned against the market value of the collateral. The leverage is calculated as $1 / h$. The Federal Reserve requires that an investor put up a minimum of 50% equity (i.e., $h = 50\%$) in a stock purchase using borrowed funds.

First, assume that a firm has $100 cash invested by the owners (i.e., no borrowed funds). The balance sheet in this case is:

Assets		*Liabilities and Equity*	
		Debt	$0
Cash	$100	Equity	$100
Total assets	$100	TL and OE	$100

If the firm uses the cash to purchase stock, the balance sheet is:

Assets		*Liabilities and Equity*	
		Debt	$0
Stock	$100	Equity	$100
Total assets	$100	TL and OE	$100

Thus, the leverage ratio is equal to 1 (i.e., $100 / $100 or 1.0 / 1.0).

Next, assume that the firm uses 50% borrowed funds and invests 50% (i.e., h = 50%) equity to buy shares of stock. Immediately following the trade, the margin account balance sheet has 50% equity and a $50 margin loan from the broker. That is:

Assets		*Liabilities and Equity*	
		Margin loan	$50
Stock	$100	Equity	$50
Total assets	$100	TL and OE	$100

The full economic balance sheet as a result of the borrowed funds (remember, owners put in $100 of equity initially so the firm now has $100 of stock and $50 of cash) is:

Assets		*Liabilities and Equity*	
Cash	$50	Margin loan	$50
Stock	$100	Equity	$100
Total assets	$150	TL and OE	$150

Thus, the leverage ratio has increased to 1.5 (i.e., $150 / $100 or 1 / 0.667). Note that the broker retains custody of the stock to use as collateral for the loan.

Short Positions and Leverage

In a short trade, the investor borrows the shares of stock and sells them. The transaction lengthens the balance sheet because the cash generated from the short sale along with the value of the borrowed securities appear on the balance sheet.

Assume the firm borrows $100 of stock and sells it short. The firm has an asset equal to the proceeds from selling the stock and a liability equal to the value of the borrowed shares. However, the firm cannot use the cash for other investments as it is collateral. It ensures that the stock can be repurchased and returned to the lender. It is in a segregated short account. In the event that the stock price increases rather than decreases, the firm must also put $50 in a margin account.

Immediately following the trade, the margin account and short account has $50 equity and a $50 margin loan from the broker.

Assets		*Liabilities and Equity*	
$150 due from broker:			
Margin	$50	Borrowed stock	$100
Short sale proceeds	$100	Equity	$50
Total assets	$150	TL and OE	$150

The firm's full economic balance sheet given the short sale is:

Assets		*Liabilities and Equity*	
Cash	\$50	Borrowed stock	\$100
Due from broker	\$150	Equity	\$100
Total assets	\$200	TL and OE	\$200

Thus, the leverage ratio has increased to 2.0 (i.e., \$200 / \$100 or 1 / 0.50). The leverage is higher in this case than in the previous margin example because the full value of the stock is borrowed in a short transaction. Leverage is inherent in the short position but is a choice in the long position. The firm only borrows 50% of the balance of the stock in the long position.

If the short position plays a hedging role in the portfolio, the position will reduce market risk. This means that leverage will overstate the overall risk because it ignores the potential risk reducing benefits of the short positions. As such, a distinction must be made between gross and net leverage. **Gross leverage** is the value of all the assets, including cash generated by short sales, divided by capital. **Net leverage** is the ratio of the difference between the long and short positions divided by capital.

Derivatives and Leverage

Derivatives allow an investor to gain exposure to an asset or risk factor without actually buying or selling the asset. Derivatives also allow investors to increase leverage. Although derivatives are generally off-balance sheet, they should be included on the economic balance sheet as they affect an investor's returns. Derivatives are synthetic long and short positions. To estimate the economic balance sheet, find the **cash-equivalent market value** for each type of derivative. Derivatives include:

- **Futures, forward contracts, and swap contracts**. These contracts are linear and symmetric to the underlying asset price. The amount of the underlying instrument represented by the derivative is set at the initiation of the contract so values can be represented on the economic balance sheet by the market value of the underlying asset. These contracts have zero net present values (NPVs) at initiation.
- **Option contracts**. These contracts have a non-linear relationship to the underlying asset price. The amount of the underlying represented by the option changes over time. The value can be fixed at any single point in time by the option delta. Thus, on the economic balance sheet, the cash equivalent market values can be represented by the delta equivalents rather than the market values of the underlying assets. These contracts do not have zero NPVs at initiation because the value is decomposed into an **intrinsic value** (which may be zero) and a **time value** (which is likely not zero).

In this next example, the counterparty is assumed to be the prime broker or broker-dealer executing the positions. This means that margin will be assessed by a single broker on a portfolio basis.

First, assume the firm enters a 1-month currency forward contract and is short $100 against the euro and the 1-month forward exchange rate is $1.25 per euro. The balance sheet is:

Assets	*Liabilities and Equity*	
$100 equivalent of €80 bank deposit	Broker loan	$100

Now, assume the firm buys a 3-month at-the-money call option on a stock index with an underlying index value of $100. The call's delta is currently 50%. The transaction is equivalent to using a $50 broker loan to buy $50 of the stock index. That is:

Assets		*Liabilities and Equity*	
$50 long index position	$50	Broker loan	$50

Next, assume the firm enters a short equity position via a total return swap (TRS). The firm pays the total return on $100 of ABC stock and the cost of borrowing the ABC stock (i.e., the short rebate). This is equivalent to taking a short position in ABC. Assuming the market price of ABC is $100, we have:

Assets		*Liabilities and Equity*	
$100 due from broker (proceeds from short sale)	$100	Borrowed ABC stock	$100

Finally, assume the firm adds short protection on company XYZ via a 5-year credit default swap (CDS) with a notional value of $100. This position is equivalent to a long position in a par-value 5-year floating rate note (FRN) financed with a term loan.

The firm's combined economic balance sheet that includes all of the derivatives positions is:

Assets		*Liabilities and Equity*	
Cash	$50	Short-term broker loan	$150
Due from broker	$150		
$50 margin			
$100 short sale proceeds		Term loan	$100
Equivalent of €80 bank deposit	$100	Borrowed ABC stock	$100
Long equity index	$50		
XYZ FRN	$100	Equity	$100
Total assets	$450	TL and OE	$450

The firm has increased its leverage to 3.5 in its long positions. The long positions combined with the short position (the ABC TRS) means the firm has gained economic exposure to securities valued at $450 using $50 of cash.

Notice that computing leverage is complex when derivatives are used. Also, correctly interpreting leverage is important since risk may be mitigated if short positions are used to hedge. For example, currency and interest rate risks can be hedged accurately. However, the positions are of the same magnitude as the underlying assets. If the positions are carried on the economic balance sheet, leverage will be overstated and other material risks in the portfolio may be ignored.

Sources of Transactions Liquidity Risk

LO 54.7: Explain methods to measure and manage funding liquidity risk and transactions liquidity risk.

An asset is liquid if it resembles money. That is, it can be exchanged for goods or services quickly and at a certain value. However, assets have to be liquidated in order to buy goods and services because we do not have a barter economy.

Transactions liquidity implies that an asset can be bought or sold without moving its price. However, large transactions may move an asset's price because they create a short-term imbalance between supply and demand. Transactions liquidity risk is fundamentally related to the costs of searching for a counterparty, the institutions required to assist in that search, and the costs of inducing a counterparty to hold a position.

In order to understand transactions liquidity risk, it is important to understand market microstructure fundamentals. These fundamentals are:

- **Trade processing costs.** The first cost is associated with finding a counterparty in a timely fashion. In addition, processing costs, clearing costs, and the costs of settling trades must also be considered. These costs do not typically increase liquidity risk except in circumstances, either natural or man-made, where the trading infrastructure is affected.
- **Inventory management.** Dealers provide trade immediacy to market participants. The dealer must hold long or short inventories of assets and must be compensated by price concessions. This risk is a volatility exposure.
- **Adverse selection.** There are informed and uninformed traders. Dealers must differentiate between liquidity or noise traders and information traders. Information traders know if the price is wrong. Dealers do not know which of the two are attempting to trade and thus must be compensated for this lemons risk through the bid-ask spread. The spread is wider if the dealer believes he is trading with someone who knows more than he does. However, the dealer does have more information about the flow of trading activity (i.e., is there a surge in either buy or sell orders).
- **Differences of opinion.** It is more difficult to find a counterparty when market participants agree (e.g., the recent financial crisis where counterparties were afraid to trade with banks because everyone agreed there were serious problems) than when they disagree. Investors generally disagree about the correct or true price on an asset and about how to interpret new information about specific assets.

These fundamentals differ across different types of market organizations. For example, in a quote-driven system, common in over-the-counter (OTC) markets, market makers are expected to publicly post 2-way prices or quotes and to buy or sell at those prices within identified transaction size limits. In contrast, order-driven systems, typically found on organized exchanges, are more similar to competitive auction models. Typically the best bids and offers are matched throughout the trading session.

Liquidity risks are introduced when bid-ask spreads fluctuate, when the trader's own actions impact the equilibrium price of the asset (called **adverse price impact**) and when the price of an asset deteriorates in the time it takes a trade to get done (called **slippage**).

In general, regulators have focused more on credit and market risks and less on liquidity risk. Liquidity risk is difficult to measure. However, since the financial crisis, more attention is being paid to measuring liquidity risks in a firm.

Transactions Cost

LO 54.8: Calculate the expected transactions cost and the spread risk factor for a transaction, and calculate the liquidity adjustment to VaR for a position to be liquidated over a number of trading days.

Assuming that daily changes in the bid-ask spread are normally distributed, the 99% confidence interval on the transactions cost in dollars is:

$$+/- \ P \times ½(s + 2.33\sigma_s)$$

where:
P = an estimate of the next day asset midprice, usually set to *P*, the most recent price observation
s = expected or typical bid-ask spread calculated as: (ask price – bid price) / midprice
σ_s = sample standard deviation of the spread

This confidence interval estimates the expected transactions costs in dollar terms. The ½(s + 2.33σ_s) component is referred to as the 99% **spread risk factor**.

Example: Computing transactions cost

Brieton, Inc., recently traded at an ask price of $100 and a bid price of $99. The sample standard deviation of the spread is 0.0002. **Calculate** the expected transactions cost and the 99% spread risk factor for a transaction.

Answer:

$$\text{midprice} = (100 + 99) / 2 = 99.50$$

$$s = (100 - 99) / 99.5 = 0.01005$$

$$\text{transactions cost} = 99.50 \times ½[0.01005 + 2.33(0.0002)] = \$0.523$$

$$\text{spread risk factor} = ½[0.01005 + 2.33(0.0002)] = 0.005258$$

Note that in this example, we use the current midprice as the estimate for the next day asset midprice.

Adjusting VaR for Position Liquidity

Liquidity-adjusted value at risk (LVaR) is a tool used to measure the risk of adverse price impact. The trader will often liquidate the position over a period of days in order to ensure an orderly liquidation of the position.

Professor's Note: The actual calculation of liquidity-adjusted VaR (using constant and exogenous spread approaches) was shown in Topic 52. Here we discuss how VaR may be overstated when adjusting for different time horizons (via the square root of time rule) since this adjustment does not account for the liquidation of positions over the time period of analysis.

Adjusting VaR for liquidity requires an estimate of the number of days it will take to liquidate a position. The number of trading days is typically denoted *T*. Assuming the position can be divided into equal parts across the number of trading days and liquidated at the end of each trading day, a trader would face a 1-day holding period on the entire position, a 2-day holding period on a fraction (T – 1) / T of the position, a 3-day holding period on a fraction (T – 2) / T of the position, and so on. The 1-day position VaR adjusted by the square root of time is estimated for a given position as:

$$\text{VaR}_t \times \sqrt{\text{T}}$$

However, this formula overstates VaR for positions that are liquidated over time because it assumes that the whole position is held for *T* days. To adjust for the fact that the position could be liquidated over a period of days, the following formula can be used:

$$\text{VaR}_t \times \sqrt{\frac{(1+\text{T})(1+2\text{T})}{6\text{T}}}$$

For example, if the position can be liquidated in four trading days (T = 4), the adjustment to the overnight VaR of the position is 1.3693, which means we should increase VaR by 37%. This is greater than the initial 1-day VaR, but less than the 1-day VaR adjusted by the square root of *T*.

Measuring Market Liquidity

Factors such as tightness, depth, and resiliency are characteristics used to measure market liquidity.

- **Tightness (or width)** refers to the cost of a round-trip transaction, measured by the bid-ask spread and brokers' commissions. The narrower the spread, the tighter it is. The tighter it is, the greater the liquidity.
- **Depth** describes how large an order must be to move the price adversely. In other words, can the market absorb the sale? The market can likely absorb a sale by an individual investor without an adverse price impact. However, if a large institution sells, it will likely adversely impact the price.
- **Resiliency** refers to the length of time it takes lumpy orders to move the market away from the equilibrium price. In other words, what is the ability of the market to bounce back from temporary incorrect prices?

Both depth and resiliency affect how quickly a market participant can execute a transaction.

Funding Liquidity Risk Management

Redemption requests, especially in times of market stress, may require hedge fund managers to unwind positions rapidly, exposing the fund to transactions liquidity risk. If this happens to many funds at once, fire sales may result. Hedge funds manage liquidity via:

- **Cash.** Cash can be held in money market accounts or Treasury bills and unencumbered liquidity. Cash is not wholly without risk, however, because money market funds may suspend redemptions in times of stress or crisis, and broker balances are at risk if the broker fails.
- **Unpledged assets.** Unpledged assets, also called assets in the box, are assets not currently being used as collateral. They are often held with a broker. Price volatility of the assets affects their liquidity. Only Treasury securities, and more specifically Treasury bills, may be used as collateral during a financial crisis. Even government agency securities were not sufficient collateral during the 2007–2009 financial crisis. Unpledged assets can be sold, rather than pledged, to generate liquidity. However, in times of market stress, asset prices are often significantly depressed.
- **Unused borrowing capacity.** This is not an unfettered source of liquidity as unused borrowing capacity can be revoked by counterparties by raising haircuts or declining to accept pledged assets as collateral when it is time to rollover the loan. These loans are typically very short term and credit can, as it did during the 2007–2009 financial crisis, disappear quickly.

During the crisis, a systemic risk event, hedge funds that had not experienced large losses still faced a liquidity crisis as investors, seeking liquidity themselves, issued redemption requests.

Key Concepts

LO 54.1

Liquidity has two essential properties, which relate to two essential forms of risk. Transactions liquidity deals with financial assets and financial markets and is related to the ability to sell an asset quickly, cheaply, and without moving the price too much. Funding liquidity is related to individual's or firm's creditworthiness.

LO 54.2

Banks only expect a fraction of deposits and other liabilities to be redeemed at any point in time. As a result, they do not hold all deposits in liquid assets, but make loans with deposits instead. This is known as a fractional-reserve bank and the process of using deposits to finance loans is known as asset-liability management (ALM).

LO 54.3

Systematic funding risks were apparent in many market sectors during the subprime mortgage crisis. Liquidity issues arose during the recent financial crisis for a variety of investment strategies.

Money market mutual funds (MMMFs) have net assets (NAVs) equal to $1.00. However, credit write-downs can result in net asset values falling below $1.00. This is known as breaking the buck. Liquidity risk can also cause NAVs to fall below $1.00.

LO 54.4

Collateral markets enhance the ability of firms to borrow money. They also make it possible to establish short positions in securities. Cash and securities may be borrowed in the market for collateral.

Firms with excess cash are more willing to lend at a low rate of interest if the loan is secured by collateral. The full value of the securities is not lent. The difference is called a haircut.

Collateralized loans are used to finance securities or other assets or trades. The securities pledged to one firm are often loaned or pledged again, hence the collateral circulates. This process is known as rehypothecation or repledging.

LO 54.5

A firm's leverage ratio is equal to its assets divided by equity. That is:

$$L = \frac{A}{E} = \frac{(E + D)}{E} = 1 + \frac{D}{E}$$

Return on equity (ROE) is higher as leverage increases, as long as the firm's return on assets (ROA) exceeds the cost of borrowing funds. This is called the leverage effect. The leverage effect can be expressed as:

$$r_E = Lr_A - (L - 1)r_D$$

LO 54.6

There is embedded leverage in short positions and derivatives such as options and swaps. Economic balance sheets can be constructed to help investors and/or firms measure the implicit leverage of these transactions.

LO 54.7

Transactions liquidity implies that an asset can be bought or sold without moving its price. Transactions liquidity risk is fundamentally related to the costs of searching for a counterparty, the institutions required to assist in that search, and the costs of inducing a counterparty to hold a position.

To understand transactions liquidity risk, one must understand market microstructure fundamentals. Trade processing costs, inventory management, adverse selection (i.e., dealing with informed versus uninformed traders), and differences of opinions regarding asset prices affect transactions liquidity.

Factors such as tightness, depth, and resiliency are characteristics used to measure market liquidity. Tightness (or width) refers to the cost of a round-trip transaction, measured by the bid-ask spread and brokers' commissions. Depth describes how large an order must be to move the price adversely. Resiliency refers to the length of time it takes lumpy orders to move the market away from the equilibrium price.

Hedge funds manage liquidity via cash, unpledged assets, and unused borrowing capacity. In times of market stress, redemption requests may require hedge fund managers to unwind positions rapidly, exposing the fund to transactions liquidity risk. If this happens to many funds at once, fire sales may result.

LO 54.8

Assuming that daily changes in the bid-ask spread are normally distributed, the 99% confidence interval on the transactions cost in dollars is:

$$+/- \ P \times \tfrac{1}{2}(s + 2.33\sigma_s)$$

The spread risk factor is equal to $\frac{1}{2}(s + 2.33\sigma_s)$.

Liquidity-adjusted VaR is a tool used to measure the risk of adverse price impact. Traders will often liquidate positions over a period of days in order to ensure an orderly liquidation of the position.

LO 54.9

Risks associated with liquidity are interrelated and can exacerbate problems. For example, an increase in funding liquidity risk can lead to an increase in transactions liquidity risk. Also, severe stress to the financial system from a liquidity risk event would impact market participants simultaneously, suggesting that the illiquidity or insolvency of one counterparty may impact other market participants.

Concept Checkers

1. Jackson Grimes, a trader for Glenn Funds, works on the repurchase agreement (repo) desk at his firm. Markets have been highly volatile but Glenn Funds has a large capital base and is sound. Grimes reports to the CEO that in the last month, the firm Glenn Funds borrows from has been consistently increasing collateral requirements to roll over repos. From the perspective of Glenn Funds, this represents:
   A. systematic risk.
   B. transactions liquidity risk.
   C. balance sheet risk.
   D. maturity transformation risk.

2. Chris Clayton, an analyst for a private equity fund, noticed that merger arbitrage strategies at several hedge funds experienced large losses in late 2007 to early 2008. These losses were likely due to:
   A. abandoned merger plans due to a lack of available financing.
   B. target prices falling precipitously due to stock market corrections.
   C. acquirers filing for bankruptcy as the subprime mortgage crisis unfolded.
   D. idiosyncratic risks surrounding the merger arbitrage strategy.

3. With respect to the valuation of money market mutual fund (MMMF) assets, funds:
   A. are not required to mark-to-market the underlying assets daily.
   B. must reflect changes in the values of underlying assets that are the result of changes in credit risks but may ignore value changes that are the result of changes in interest rates.
   C. will set the notional values of each of the underlying assets equal to $1.00.
   D. are not allowed to invest in any asset with a rating below AAA because asset values must not fluctuate outside of a 10% range around the historical value in order to keep the notional value equal to $1.00.

4. Charleston Funds intends to use leverage to increase the returns on a convertible arbitrage strategy. The return on assets (ROA) of the strategy is 8%. The fund has $1,000 invested in the strategy and will finance the investment with 75% borrowed funds. The cost of borrowing is 4%. The return on equity (ROE) is closest to:
   A. 4%.
   B. 32%.
   C. 20%.
   D. 12%.

5. Brett Doninger recently placed an order to sell a stock when the market price was $42.12. The market was volatile and, by the time Doninger's broker sold the stock, the price had fallen to $41.88. In the market, this phenomenon is known as:
   A. adverse selection.
   B. transactional imbalance.
   C. slippage.
   D. the spread risk factor.

Concept Checker Answers

1. **C** Funding liquidity risk or balance sheet risk results when a borrower's credit position is either deteriorating or is perceived by market participants to be deteriorating. It also occurs when the market as a whole deteriorates. Under these conditions, creditors may withdraw credit or change the terms of credit. In this case, the lender is increasing the haircut and is thus changing the terms of credit. Glenn Fund's creditworthiness does not actually have to decline for a lender to withdraw credit or change the terms of credit.

2. **A** Systematic funding risks were apparent in many market sectors during the subprime mortgage crisis. Hedge funds engaged in merger arbitrage experienced losses in the early stages of the subprime mortgage crisis. After a merger is announced, the target's stock price typically increases and the acquirer's price sometimes declines due to increased debt. The merger arbitrage strategy exploits the difference between the current and announced acquisition prices. Hedge funds experienced large losses as mergers were abandoned when financing dried up.

3. **A** MMMFs use a form of accounting called the amortized cost method, under the Securities and Exchange Commission's (SEC) Rule 2a – 7. This means that MMMF assets do not have to be marked-to-market each day, as required for other types of mutual funds. However, the values of the underlying assets in the fund, despite their relative safety, are subject to change. As such, redemptions may be limited if asset values fall.

4. **C** debt = \$1,000 × 0.75 = \$750
leverage ratio = total assets / equity
leverage ratio = \$1,000 / \$250 = 4

$$r_E = Lr_A - (L - 1)r_D$$

where:
r_A = return on assets
r_E = return on equity
r_D = cost of debt
L = leverage ratio

return on equity = 4(8%) – [(4 – 1)(4%)] = 32% – 12% = 20%

5. **C** Liquidity risks are introduced when bid-ask spreads fluctuate, when the trader's own actions impact the equilibrium price of the asset (called adverse price impact), and when the price of an asset deteriorates in the time it takes a trade to get done. When the price deteriorates in the time it takes to get a trade done, it is called slippage.

The following is a review of the Operational and Integrated Risk Management principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

The Failure Mechanics of Dealer Banks

Topic 55

Exam Focus

Understanding the key failure mechanics for dealer banks is crucial for mitigating liquidity and solvency risks. Liquidity risks are accelerated when counterparties or prime broker clients question the solvency of a large dealer bank and, in turn, limit their exposure. This results in increased liquidity risk and insolvency risk for the bank and increased systemic liquidity risk for the financial markets in which dealer banks play commingled roles. Dealer banks play key roles as prime brokers, securities underwriters, special purpose entities (SPE), and as counterparties in the over-the-counter (OTC) derivatives and repo markets. Diseconomies of scope in risk management and corporate governance were revealed by the recent market crisis. Thus, new policies to alleviate dealer bank risks were implemented to address off-balance sheet risks, capital requirements, leverage, liquidity risks, clearing banks, and adverse selection effects in "toxic" asset markets.

Functions of Dealer Banks

LO 55.1: Describe the major lines of business in which dealer banks operate and the risk factors they face in each line of business.

Large dealer banks provide a variety of intermediary functions in the markets for over-the-counter (OTC) derivatives, repurchase agreements, and securities. In addition, large dealer banks act as a prime broker for hedge funds and provide asset management for wealthy individuals and institutions.

Large dealer banks play an important function in the **OTC derivatives market**. Dealer banks transfer the risk of the derivatives positions requested by counterparties by creating new derivatives contracts with other counterparties. Examples of types of OTC derivatives are interest rate swaps, collateralized debt obligations (CDOs), collateralized mortgage obligations (CMOs), and credit default swaps (CDSs).

Counterparty risk in the OTC market refers to the risk that one or more of the counterparties will default on their contractual obligations. The total amount of wealth does not change as derivatives transfer wealth from one counterparty to another as contingencies are realized over time. However, if a counterparty incurs large losses, their derivatives contracts incur frictional bankruptcy costs that result in distress costs for their counterparties. Dealer banks are often counterparties to other dealer banks and large market players. Therefore, the solvency and liquidity problems of one large dealer bank can quickly result in increased systemic risk and a potential liquidity crisis.

If the dealer bank does not have the liquidity to function, they will become insolvent. The failure of a large dealer bank would result in increased systemic risk for the OTC market. When counterparties question the solvency of a dealer bank, they will take actions to reduce their exposure and exit their positions. For example, the default of Lehman Brothers in September of 2008 not only disrupted the OTC derivatives markets, but the repercussions were also felt by other financial markets and institutions.

Another important function of large dealer banks is in the short-term repurchase or **repo market**. Large dealer banks finance significant fractions of another dealer bank's assets through repos. Prior to the recent crisis, dealer banks used overnight repos to finance holdings of agency securities, corporate bonds, Treasuries, mortgages, and collateralized debt obligations (CDOs) with little incremental capital. Some large dealer banks had very high leverage due to the lack of capital requirements for these repos. The high leverage caused significant solvency risk when the use of subprime mortgages as collateral was questioned.

The systemic and firm specific risk is significantly increased if a repo counterparty questions the solvency of a dealer bank. Counterparties are unlikely to renew repos, and the repo creditors may be legally required to sell collateral immediately. Without a government or central bank stepping in as a lender of last resort, dealer banks have no place to turn when repos are not renewed. As many dealer banks act as counterparties for other positions, the solvency of one dealer bank is likely to have a ripple effect and greatly increase the systemic risk of these markets.

Dealer banks provide investment banking functions through the management and underwriting of securities issuances. These investment banking functions also include advising corporations regarding mergers and acquisitions and merchant banking functions, such as the buying and selling of oil, metals, and other commodities. These functions provide an important source of revenue for dealer banks. An additional strain on liquidity is caused by the lack of cash inflows when issuers question the solvency of the dealer bank and take their business elsewhere. This can lead to systemic risk as new issues and the liquidity of existing issues are halted, as few institutions are able or willing to fill the void when a large dealer bank's solvency or liquidity are questioned.

Large dealer banks act as a **prime broker** to large investors such as hedge funds. In this context, the services provided by the dealer banks include custody of securities, clearing, securities lending, cash management, and reporting. When the solvency of a prime broker is questionable, a hedge fund could demand cash margin loans from the dealer that are backed by securities. The prime broker may not be able to use those same securities as collateral with other lenders who may also question their solvency. Thus, the dealer bank's liquidity position is weakened if large clients reduce their exposure by exiting their positions or entering new positions to offset their risk.

In addition, if prime broker clients leave, then their cash and securities are no longer in the pool of funds to meet the dealer bank's liquidity needs for other clients. A systemic shortage of collateral and a liquidity crisis can result from the reduction of collateral securities caused by the flight of prime brokerage clients. Systemic risk is even greater when hedge funds do not mitigate their exposure through diversification. Prior to the recent financial crisis, hedge funds had significant positions with only a few dealer banks.

Dealer banks also provide an important function as a counterparty for derivatives for brokerage clients. Dealer banks sometimes operate "internal hedge funds" and private equity partnerships. Off-balance sheet entity functions such as internal hedge funds, structured investment vehicles, and money market funds can have substantial losses. The dealer banks have an incentive to voluntarily support these entities to protect their reputation and franchise value. When a dealer bank shows signs of distress, counterparties and others may begin to exit their relationships, which severely increases the dealer bank's liquidity risk.

In addition, large dealer banks provide traditional commercial banking functions, such as gathering deposits for corporate and consumer lending. The risks for a dealer bank are similar to a traditional bank with respect to these functions. However, prior to the recent financial crisis, dealer banks did not have access to the discount window (borrowing money from the central bank), and their accounts were not federally insured. For these reasons, a run on the bank's deposits was more likely to lead to a liquidity crisis. With increased concerns of the solvency of large dealer banks, the availability of credit across the industry was threatened. This had the potential to lead to severe market slowdowns if borrowers were unable to obtain credit.

Dealer Bank Markets

Large dealer banks operate in markets that are outside the scope of traditional bank-failure resolution mechanisms, such as conservatorship or receivership. The dealer banks are organized under the umbrella of holding companies in order to provide the wide variety of commercial banking, merchant banking, investment banking, brokerage, and off-balance sheet partnership activities. In addition, dealer banks often have large asset-management divisions that provide custody of securities, cash management, brokerage, and alternative investments vehicles. Dealer banks are also typically the general partner with limited partner clients.

In the primary securities market, dealer banks are the security underwriter. They buy equity and bond securities from issuers and sell them to institutions and investors over a period of time. Dealer banks also play a major role in the secondary securities market in providing liquidity to the market. They are the primary intermediary in the OTC securities markets by assisting in the private negotiation between investors and corporations, municipalities, certain national governments, and securitized credit products. Dealer banks are also actively involved in publicly traded equity markets by acting as brokers, custodians, securities lenders, and facilitating large block trades.

A major market in which dealer banks operate is the repurchase agreements, or **repos**, market. Repos are short-term cash loans collateralized by securities. In the repo market, one counterparty borrows cash from another counterparty. The majority of repos are for a very short period of time, such as overnight. The loans are collateralized by government bonds, corporate bonds, mortgages, agency securities, or other securities such as CDOs. In order to reduce counterparty risk, a clearing bank often acts as a third party and holds the collateral. The clearing bank facilitates the trade and somewhat reduces the risk of default for the lender. It is common for counterparties to renew these positions on a continuous basis as long as the solvency of the dealer bank is not questioned. It is not uncommon for these counterparties to be another dealer bank.

Dealer banks are usually counterparties in the OTC derivatives market. The most prominent OTC derivatives are interest rate swaps where variable rate commitments often linked to the London Interbank Offering Rate (LIBOR) are exchanged for a fixed rate for a specific time period. Dealer banks typically perform what is known as a "matched book" dealer operation. They transfer the risk of the derivatives positions requested by counterparties by creating new derivatives contracts with other counterparties, who are oftentimes other dealer banks. Thus, dealer banks have large OTC derivatives exposures with other dealer banks. In addition to dealing with interest rate swaps, dealers are often counterparties in CDSs. In these contracts, the dealer bank transfers the default risk rather than the interest rate risk for the counterparties involved in the contracts.

Some large dealer banks are very active in off-balance sheet financing. In these markets, a bank can sell residential mortgages or other loans to a special purpose entity (SPE). The SPE compensates the sponsoring bank for the assets with the proceeds of debt that it issues to third-party investors or hedge funds. The SPE pays for the principal and interest of the debt issued with the cash flows from the mortgages or other assets that were purchased from the sponsoring bank. Thus, the SPE holds the collateralized pool of assets and provides an innovative product for hedge funds and other investors to purchase. These SPEs also provide a means for financial institutions to diversify their exposure by transferring risk to other investors who are either in or outside the financial industry.

For example, prior to the recent financial crisis, dealer banks were actively participating as sponsor banks for structured investment vehicles (SIVs), which are a form of a special purpose entity. The SIV finances residential mortgages or other debt obligations with short-term debt sold to other investors in the form of CDOs and CMOs.

Before the recent crisis, banks were not required to include the off-balance sheet assets and debt obligations in minimum capital requirement and accounting reports. Thus, some dealer banks became highly leveraged as they were allowed to operate much larger loan purchases and origination businesses with a limited amount of capital. The fall in residential housing values in the summer of 2007 led to the rise of mortgage defaults, which threatened the ability of the SIV to make payments. As short-term creditors became concerned with the solvency of the SIVs, they refused to renew loans, and this created a liquidity and solvency issue for SIVs. Dealer banks had to provide support to SIVs to protect its reputation and franchise value.

Diseconomies of Scope

As mentioned, dealer banks act as holding companies in order to provide a wide variety of commercial banking, prime brokerage, investment banking, asset management, and off-balance sheet activities. The recent financial crisis caused many to question the ability of dealer banks to manage risks properly. It is sometimes argued that forming large bank holding companies results in economies of scope with respect to information technology, marketing, and financial innovation. However, the recent financial crisis clearly identified diseconomies of scope in risk management and corporate governance. The executive management and board of directors did not fully understand or control the risk taking activities within their organizations.

For example, prior to their insolvency, Bear Stearns and Lehman relied heavily on overnight repos with leverage ratios above 30. These dealer banks held these assets on their balance

sheets with little incremental capital. Management did not properly manage the amount of off-balance sheet risk the bank was exposed to. Thus, the over-leveraged positions made it impossible to overcome the liquidity and solvency issues that quickly arose when the values of the bank's assets were questioned. Increased awareness or more appropriate risk models may have prevented the insolvency of these dealer banks.

Liquidity Concerns for Dealer Banks

LO 55.2: Identify situations that can cause a liquidity crisis at a dealer bank and explain responses that can mitigate these risks.

A liquidity crisis for a dealer bank is accelerated if counterparties try to reduce their exposure by restructuring existing OTC derivatives with the dealer or by requesting a novation (as discussed in the following). The flight of repo creditors and prime brokerage clients can also accelerate a liquidity crisis. Lastly, the loss of cash settlement privileges is the final collapse of a dealer bank's liquidity.

As mentioned previously, when OTC derivatives counterparties question the solvency of a dealer bank, they will begin to reduce their exposures to the dealer. A counterparty could reduce their exposure by borrowing from the dealer or by entering into new offsetting derivatives contracts with the dealer. A counterparty may also request to have in-the-money options revised to at-the-money strike prices and, thus, reduce their exposure to the dealer by receiving cash from the option position.

Another means that a counterparty has of reducing their exposure to a dealer is through a **novation** to another dealer. For example, a hedge fund may use a credit default swap from a dealer to protect themselves from a loss on a borrower. If the hedge fund was concerned about the solvency of the dealer bank, they could request a novation from another dealer bank to protect themselves from default arising from the original dealer bank. Although these novations are often granted by dealer banks, in the case of Bear Stearns, the request was denied, which raised additional concerns regarding the solvency of Bear Stearns. In addition to decreasing the reputation capital and franchise value of this dealer bank, the liquidity position was also under increased stress. A novation could result in the removal of the cash collateral of the original dealer bank and transfer of this collateral to the second dealer bank.

Central clearing mitigates the liquidity risk caused by derivatives counterparties exiting their large dealer bank exposures. OTC derivatives are novated or "cleared" to a central clearing counterparty that stands between the original counterparties. The use of a central clearing counterparty also mitigates the systemic risk of financial markets and institutions when the solvency of a large dealer bank is questioned. However, the use of central clearing counterparties is only effective with derivatives that contain relatively standard terms. Thus, this was not an effective means of dealing with the infamous customized AIG credit derivatives.

Further liquidity pressure can arise if derivative counterparties desire to reduce their exposure by entering new contracts that require the dealer bank to pay out cash. For example, a dealer bank may try to signal their strength to the market by quoting competitive bid-ask spreads on an OTC option. If the bid price is then accepted, the dealer

must settle with a cash payment to the counterparty which reduces their liquidity. If the dealer refuses to quote competitive bid prices, it may further signal their liquidity concerns to the market.

Money market funds, securities lenders, and other dealer banks finance significant fractions of a dealer bank's assets through short-term repurchase agreements. As mentioned previously, if the repo counterparty questions the solvency of a dealer bank, they are unlikely to renew repos. In this event, the repo creditors may have an incentive, or be legally required, to sell the collateral immediately. If the sale of the collateral is less than the cash position, then the dealer counterparty may face litigation for the improper disposal of assets. Without a government or central bank stepping in as a lender of last resort, dealer banks have no place to turn when repos are not renewed. They could reinvest their cash in new repos, but other counterparties are unlikely to take these positions if the dealer bank's solvency is questioned.

The dealer bank can mitigate the liquidity risk caused by a run of short-term creditors by establishing lines of bank credit, holding cash and liquid securities, and by laddering the maturities of its liabilities. When a dealer bank ladders its liabilities, the maturities are spread out over time so that only a small fraction of its debt needs to be refinanced overnight. In 2008, the New York Federal Reserve Bank created the Primary Dealer Credit Facility to finance securities of investment banks. Immediately following the failure of Lehman, the remaining two dealer banks, Morgan Stanley and Goldman Sachs, became regulated bank holding companies. As a bank holding company, the firms gained access to the discount window and could turn to the government for financial support, including FDIC deposit insurance and loan guarantees.

Prime brokerage accounts are a source of cash inflows for large dealer banks. In normal circumstances, the cash and securities of prime brokerage clients are a source of liquidity for the bank. In the United Kingdom, assets from client prime brokerage accounts are commingled with the bank's own assets. However, in the United States, dealer banks are allowed to pool the money together into a separate account from the bank's own funds. Thus, the prime broker is able to use the cash from one client to help meet the liquidity needs of another client.

As mentioned previously, when the solvency of a prime broker is questionable, a hedge fund could demand cash margin loans from the dealer that are backed by the securities held in their account with the prime broker. The prime broker may not be able to use those same securities as collateral with other lenders who may question their solvency. Lenders may not find any incentive to lend to the questionable dealer bank. Thus, even without a run by prime brokerage accounts, considerable strain could be placed on the dealer bank's liquidity position.

In addition, if prime broker clients do leave on short notice, then their cash and securities are no longer in the pool of funds to meet the needs of other clients. In this case, the dealer bank must use its own cash to meet liquidity needs. The reduction of collateral securities caused by the flight of prime brokerage clients can lead to a systemic shortage of collateral and a liquidity crisis. In the future, hedge funds are likely to mitigate their exposure to a few dealer banks by diversifying their sources of prime brokerage with custodian banks.

Under normal conditions, a clearing bank may extend daylight overdraft privileges to clearing customers who are creditworthy. However, when the solvency of a dealer bank is questioned, the clearing bank may refuse to process transactions that are insufficiently funded by the dealer bank's cash fund account. For example, in the case of Lehman's default, J.P. Morgan Chase was the clearing bank that invoked its "full right of offset." Under this legal right, J.P. Morgan Chase was able to offset their exposures using Lehman's cash, and at the same time, discontinued to make cash payments during the day on Lehman transactions that would bring Lehman's account below zero. The failure to meet its transactions obligations on that day forced Lehman into bankruptcy. To mitigate this risk in the future, "emergency banks" are proposed to act as either a clearing bank or a tri-party repo "utility."

The basic economic principles causing a liquidity crisis, and potentially the insolvency of a large dealer bank, are not that different from the traditional retail bank run. Banks may finance illiquid assets with short-term deposits. However, an unexpected liquidity demand from depositors or the inability of borrowers to repay their loans may lead to concerns about the solvency of the bank. If the concern persists, a bank run could lead to liquidity problems, and the concern about the bank's failure could end up as a self-fulfilling prophecy.

While the basic economic principles of a bank run are similar for large dealer banks and retail banks, the institutional mechanisms and the systemic destructiveness are very different. For example, dealer banks play an essential role in providing liquidity in the OTC derivatives and securities markets. When the solvency of a dealer bank is questioned, counterparties of these markets and prime brokerage clients begin to reduce their exposure to the dealer. The OTC derivatives counterparty may reduce their exposure by borrowing from the dealer, entering new offsetting derivatives contracts with the dealer, or requesting a novation. A counterparty may also request to receive cash from options positions that are in-the-money by having them revised to at-the-money. Prime broker clients may remove collateral and cash, which results in further accelerating the liquidity crisis. The fact that dealer banks are often counterparties to other dealer banks increases the systemic risk in the financial markets where dealer banks play essential roles.

Another area that dealer banks are very active involving liquidity is the repo markets. Especially in cases where the dealer banks are highly leveraged, the liquidity position is severely threatened when the dealer bank's solvency is questioned and counterparties are unwilling to renew repo positions overnight. Thus, a dealer bank is involved in many functions that result in increased liquidity pressures that traditional banks are not exposed to.

Polices to Alleviate Dealer Bank Risks

LO 55.3: Describe policy measures that can alleviate firm-specific and systemic risks related to large dealer banks.

The 2009 Public Private Investment Partnership (PPIP) was instituted by the U.S. Treasury Department's 2008 **Troubled Asset Relief Program** (TARP) to help dealer banks and the financial industry recover from the crisis at hand. One of the policy objectives was to mitigate the effect of adverse selection in the market for "toxic" assets, such as the CDOs backed by subprime mortgages. Adverse selection is the principle that buyers are only willing to buy the assets at a deep discount due to the information asymmetries that exist regarding the asset's true value. A dealer bank may be forced to sell illiquid assets in order to meet liquidity needs. This results in additional losses due to the lack of demand for those assets. The PPIP subsidizes bidders of "toxic assets" by offering below-market financing rates and absorbing losses beyond a predetermined level.

The United States Federal Reserve System and the Bank of England provided new secured lending facilities to large dealer banks when they were no longer able to obtain credit from traditional counterparties or the repo market. When the dealer bank's solvency is questioned, tri-party clearing banks are likely to limit their exposure to the dealer bank. A tri-party repo utility is proposed as an alternative and would be designed to have fewer conflicting incentives and less discretion in rolling over a dealer's repo positions. New standards could be adapted for transaction documentation, margin requirements, and daily substitution of collateral with respect to repos. These standards could be incorporated through either the new repo utility or traditional tri-party clearing approaches.

Another potential approach is the creation of an "emergency bank" that could manage the orderly unwinds of repo positions of dealer banks with liquidity difficulties. The central bank would grant access to the discount window for the emergency bank to insulate critical clearing banks from losses during this unwinding process.

Capital requirements will most likely be increased and include off-balance sheet positions in an effort to reduce the leverage positions of dealer banks. The separation of tri-party repo clearing from other clearing account functions would also reduce a dealer bank's leverage by tightening the dealer's cash-management flexibility.

Central clearing will reduce the threat of OTC derivatives counterparties fleeing a questionable dealer bank. Although this would not eliminate the liquidity effect resulting from a derivative counterparty reducing their exposure to a particular dealer bank, it would reduce the total exposure to the dealer that would need to be managed through clearing.

Some large dealer banks and financial institutions are viewed as being "too-big-to-fail" based on the systemic risk their insolvency would place on the financial markets. Therefore, another proposed resolution for large dealer banks with questionable solvency that are deemed too-big-to-fail is to provide bridge banks similar to the approach used for traditional banks.

Key Concepts

LO 55.1

Large dealer banks are active participants in over-the-counter (OTC) derivatives, repo, and securities markets. Their functions in these markets, as well as asset managers and prime brokers, result in a variety of liquidity risks when their solvency is questioned and counterparties reduce their exposure with them.

LO 55.2

A liquidity crisis is accelerated when prime broker clients or counterparties in the OTC derivatives or repo markets question the solvency of a dealer bank and desire to exit their positions or reduce their exposures with the dealer bank.

LO 55.3

The creation of emergency banks in the form of tri-party repo utilities and clearing banks are policy proposals to mitigate firm specific and systemic liquidity risk in the OTC derivatives and repo markets. The U.S. Treasury Department's 2008 Troubled Asset Relief Program (TARP) was designed to mitigate adverse selection in "toxic" asset markets by providing below market financing and absorbing losses above a pre-specified amount.

Concept Checkers

1. A dealer bank's liquidity crisis is least likely to be accelerated by:
   A. the refusal of repurchase agreement creditors to renew their positions.
   B. the flight of prime brokerage clients.
   C. a counterparty's request for a novation through another dealer bank.
   D. depositors removing their savings from the dealer bank.

2. Banks are most likely to diversify their exposure to a specific asset class such as mortgages by grouping these assets together and selling them to:
   A. hedge funds.
   B. government agencies.
   C. the U.S. Federal Reserve.
   D. special purpose entities.

3. The formation of large bank holding companies results in diseconomies of scope with respect to:
   A. risk management.
   B. technology.
   C. marketing.
   D. financial innovation.

4. One potential solution for mitigating the liquidity risk caused by derivatives counterparties exiting their large dealer bank exposures is most likely the:
   A. use of central clearing.
   B. use of a novation through another dealer bank.
   C. requirement of dealer banks to pay out cash to reduce counterparty exposure.
   D. creation of new contracts by counterparties.

5. Which of the following items is not a policy objective of the U.S. Treasury Department's 2008 Troubled Asset Relief Program to help dealer banks recover from the subprime market crisis?
   A. Provide below-market financing rates for bidders of "toxic" assets.
   B. Absorb losses beyond a pre-specified level.
   C. Force the sale of illiquid assets in order to better determine the "true" value.
   D. Mitigate the effect of adverse selection.

Concept Checker Answers

1. **D** A liquidity crisis for a dealer bank is accelerated if counterparties try to reduce their exposure by restructuring existing OTC derivatives with the dealer or by requesting a novation. The flight of repo creditors and prime brokerage clients can also accelerate a liquidity crisis. Lastly, the loss of cash settlement privileges is the final collapse of a dealer bank's liquidity.

2. **D** Banks can diversify their exposure to a specific asset class, such as mortgages, by grouping these assets together and selling them to special purpose entities.

3. **A** Some argue that information technology, marketing, and financial innovation result in economies of scope for large bank holding companies. Conversely, the recent financial crisis raised the concern that the size of bank holding companies creates diseconomies of scope with respect to risk management.

4. **A** One potential solution for mitigating the liquidity risk caused by derivatives counterparties exiting their large dealer bank exposures is the use of central clearing through a counterparty. However, central clearing is only effective when the underlying securities have standardized terms. The reduction of a counterparty's exposure through novation, entering new offsetting contracts, or requiring a dealer bank to cash out of a position will all reduce the liquidity of the dealer bank.

5. **C** The U.S. Treasury Department's 2008 Troubled Asset Relief Program was designed to create policies to help dealer banks recover from the subprime market crisis by mitigating the effect of adverse selection, by providing below-market financing rates for bidders of "toxic" assets, and by absorbing losses beyond a pre-specified level. Forcing the sale of illiquid assets would worsen the liquidity position of the troubled dealer bank.

The following is a review of the Operational and Integrated Risk Management principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

Stress Testing Banks

Topic 56

Exam Focus

This topic focuses on the use of bank stress testing to determine if liquidity and capital are adequate. The discussion focuses primarily on capital adequacy but notes that the issues are similar with respect to liquidity. For the exam, understand the details of the 2009 Supervisory Capital Assessment Program (SCAP), the first stress testing required after the 2007–2009 financial crisis. Also, be able to explain the issue of coherence in stress testing and describe the challenges with modeling the balance sheet using stress tests in the context of the stress test horizon. Finally, understand the differences in disclosure between U.S. and European stress tests and the way that stress test methodologies and disclosure have changed since the 2009 SCAP.

Stress Testing

In the wake of the 2007–2009 financial crisis, regulators and other policymakers realized that standard approaches to risk assessment, such as regulatory capital ratio requirements, were not sufficient. At that point, supervisory **stress testing** became a popular tool for measuring bank risk. There was a "pop-quiz" quality to the post-financial crisis stress tests. They were difficult to manipulate because they were sprung on banks at short notice. As a result, the information provided by the stress tests to regulators and the market was truly new. This allowed financial markets to better understand bank risks and, as a result, regain a level of trust in the banking sector.

The goal of stress testing, as well as capital/liquidity and "economic capital/liquidity" (i.e., internal, bank-specific) models, is to assess how much capital and liquidity a financial institution needs to support its business (i.e., risk taking) activities. It is relatively easy for banks to swap out of lower risk assets and into higher risk assets. Stress testing provides clarity about the true risk and soundness of banks.

Stress testing is an old tool that banks and other firms have used to examine risk. It asks the question "what is the institution's resilience to deteriorating conditions?" and simulates financial results given various adverse scenarios. Stresses are generally of two basic types: scenarios or sensitivities. An example of a scenario is a severe recession. An example of sensitivity is a significant increase in interest rates. Risk managers can stress test the sensitivity of a single position or loan or an entire portfolio.

Supervisory Capital Assessment Program (SCAP)

LO 56.1: Describe the historical evolution of the stress testing process and compare methodologies of historical EBA, CCAR and SCAP stress tests.

In the wake of the financial crisis, there was much uncertainty about the soundness of the U.S. banking system. Regulators needed to assess the capital strength of financial institutions. If there was a gap between what a bank needed in terms of capital and what it had, regulators had to find a credible way to "fill the hole." The 2009 U.S. bank stress test, known as the **Supervisory Capital Assessment Program** (SCAP), was meant to serve that purpose. It was the first macro-prudential stress test after the 2007–2009 financial crisis. Macro-prudential regulation focuses on the soundness of the banking system as a whole (i.e., focuses on systematic risks) while micro-prudential regulation focuses on the safety and soundness of the individual institution.

At this point the Federal government planned to infuse equity capital into banks that were undercapitalized based on stress testing. The Treasury intended to borrow money and "downstream" it as equity in banks via the Treasury's Capital Assistance Program (CAP). If banks could not convince investors to fill the hole (i.e., infuse banks with needed equity capital), current investors would be diluted by the government's equity investment. In the end, 19 SCAP banks were required to raise $75 billion within six months. The undercapitalized banks raised $77 billion of Tier 1 common equity and did not need to draw on the CAP funds.

Prior to 2009, stress testing was relatively simple. Figure 1 summarizes the differences in stress testing pre-SCAP and post-SCAP.

Figure 1: Comparison of Stress Testing Pre-SCAP and Post-SCAP

Pre-SCAP	*Post-SCAP*
Primarily assessed exposure to single-shocks (e.g., volatility increases OR interest rate increases OR increasing unemployment).	Considers broad macro-scenarios and market-wide stresses with multiple factors occurring/changing at once, as evidenced in the 2007–2009 financial crisis.
Focused on specific bank products or business units (e.g., lending or trust).	Focuses on the whole firm, a more comprehensive look at the effect of the stress scenarios on the institution.
Typically focused on earnings shocks (i.e., losses) but not on capital adequacy.	Explicitly focuses on capital adequacy. Considers the post-stress common equity threshold to ensure that a bank remains viable.
Focused exclusively on losses.	Focuses on revenues, costs, and projected losses.
Stress testing was static in nature.	Stress testing is now dynamic and path dependent.

Professor's Note: We will compare and contrast SCAP, CCAR, and EBA stress tests later in this topic.

Challenges in Designing Stress Tests

LO 56.2: Explain challenges in designing stress test scenarios, including the problem of coherence in modeling risk factors.

One of the challenges of designing useful stress tests is **coherence**. The sensitivities and scenarios must be extreme but must also be reasonable or possible (i.e., coherent). Problems are inherently multi-factored, making it more difficult to design a coherent stress test. For example, an increase in volatility can lead to credit markets freezing. High unemployment and falling equity prices often go hand-in-hand. It is not sufficient to specify one potential problem (i.e., risk factor) because the others do not remain fixed. The supervisor's key challenge is to specify the joint outcomes of all relevant risk factors.

Additionally, not everything goes bad at once. For example, if some currencies are depreciating, others must be appreciating. If there is a "flight to quality," there must also be safe haven assets in the stress model. So while it is important to look at, for example, what happens if U.S. Treasury debt becomes riskier and is no longer a safe haven, the model would at the same time have to identify the "risk-free" asset(s) in which capital would flee under those circumstances.

The problem is even greater when designing stress scenarios for marked-to-market portfolios of traded securities and derivatives. Risk is generally managed with a value at risk (VaR) system. Hundreds of thousands of positions in the trading book must be mapped to thousands of risk factors, tracked on a daily basis. The data that results is used to estimate volatility and correlation parameters. It is very difficult to find coherent outcomes in such a complex, multi-dimensional universe.

The 2009 SCAP tested rather simple scenarios with three variables: growth in GDP, unemployment, and the house price index (HPI). Historical experience was used for the market risk scenario (i.e., the financial crisis—a period of "flight to safety," the failure of Lehman, and higher risk premia). While the market risk scenario did not test for something new, the overall framework achieved coherence of financial and other stresses of the time period.

One thing to note is that prior to 2011 all supervisory stress tests imposed the same scenarios on all banks (i.e., a one-size-fits-all approach to stress testing). In recognition of the problem, the 2011 and 2012 Comprehensive Capital Analysis and Review (CCAR) asked banks to submit results from their own stress scenarios in addition to the supervisory stress scenario in an attempt to reveal bank-specific vulnerabilities. This was an important step forward from the 2009 SCAP as it gave supervisors a sense of what banks think are the high risk scenarios. This provides regulators with not only bank-specific (i.e., micro-prudential) insight but also improves macro-prudential supervision as it highlights common risks across banks that may have been underemphasized or unnoticed before.

Challenges in Modeling Losses and Revenues

LO 56.3: Explain challenges in modeling a bank's revenues, losses, and its balance sheet over a stress test horizon period.

Current stress tests are based on macro-scenarios (e.g., unemployment, GDP growth, the HPI). One concern is how to translate the macro-risk factors employed in stress testing into micro (i.e., bank-specific) outcomes related to revenues and losses. Supervisors need to map from macro-factors into intermediate risk factors that drive losses in specific products and geographic areas. Although not limited to these products, geographic differences are especially important in modeling losses in both commercial and residential real estate lending.

Credit card losses are particularly sensitive to unemployment figures. For example, unemployment was 12.9% in Nevada in July 2011, 3.3% in North Dakota, and the national unemployment rate was 9.1%. Credit card loss rates varied dramatically from region to region during this period. The geographic diversity with respect to macro-factors makes a "one-size-fits-all" stress testing regime less meaningful.

Geography is not the only difference supervisors must contend with. Risks affect different asset classes in different ways. For example, during recessions people buy fewer automobiles overall. However, if a person needs a car during a recession, he is more likely to buy a used car. Thus, if default rates increase, loss given default (LGD) (i.e., loss severity) may not increase as much.

The business cycle also affects different industries at different times. Consider the airline industry versus the healthcare industry during a recession. Airplanes are collateral for loans to airlines. If the airline industry is depressed, the bank gets stuck with collateral that is very difficult to sell except at extremely depressed prices. Healthcare is somewhat recession-proof but that doesn't mean the bank can transform an airplane it is stuck with into a hospital. These factors increase the difficulty of mapping broader macro-factors to bank-specific stress results.

Modeling revenues over a stress test horizon period is much less developed than modeling losses. The 2009 SCAP did not offer much clarity on how to calculate revenue during times of market stress. The main approach to modeling revenue is to divide a bank's total income into interest and non-interest income. The yield curve can be used to estimate interest income, and it can reflect credit spreads during stress testing scenarios; however, it remains unclear how bank profitability is directly influenced by the net impact of changing interest rates. Estimating noninterest income, which includes fees and service charges, is even more difficult to model. This is alarming given the steady increase in noninterest income among U.S. banks.

Challenges in Modeling the Balance Sheet

The typical stress test horizon is two years. Over this period, both the income statement and balance sheet must be modeled to determine if capital is adequate post-stress. Generally speaking, capital is measured as a ratio of capital to assets. There are different types of capital (e.g., Tier 1 and Tier 2) but in general (and for the sake of simplicity), capital can be

defined as common equity. **Risk-weighted assets** (RWA) are computed based on the Basel II risk weight definitions. For example, agency securities have a lower risk weight than credit card loans.

In a stress model, the beginning balance sheet generates the first quarter's income and loss from the stressed scenario, which in turn determines the quarter-end balance sheet. At that point, the person modeling the risk must consider if any assets will be sold or originated, if capital is depleted due to other actions such as acquisitions or conserved as the result of a spin-off, if there are changes made to dividend payments, if shares will be repurchased or issued (e.g., employee stock or stock option programs), and so on. These decisions make modeling the balance sheet over the stress horizon quite difficult. The stress model doesn't determine if it would be a good time to sell a subsidiary or lower dividend payments.

The challenges of balance sheet modeling exist under both static and dynamic modeling assumptions. The bank must maintain its capital (and liquidity) ratios during all quarters of the stress test horizon. At the end of the stress horizon the bank must estimate the reserves needed to cover losses on loans and leases for the next year. This means that a two-year horizon stress test is actually a three year stress test (i.e., a T-year stress test requires the bank to estimate required reserves to cover losses for T+1 years).

Stress Test Comparisons

Disclosure was a significant feature of the 2009 SCAP. It disclosed projected losses for each of the 19 participating banks for eight asset classes. It also disclosed resources the bank had to absorb losses other than capital (e.g., pre-provision net revenue and reserve releases if available). This high level of disclosure created transparency. It allowed investors and the market to check the severity of stress tests and to comprehend stress test outcomes at the individual bank level. Before the 2009 SCAP, banks only reported realized losses, not forecasted losses (i.e., possible losses given the stress scenario).

The 2011 CCAR required only that macro-scenario results be published, not bank level results. This differed dramatically from the 2009 SCAP requirements. The market had to figure out whether a bank had passed the test or not (i.e., market participants had to "do the math" themselves). For example, if a bank increased its dividend, it was assumed by the market to have "passed" the stress test. However, the 2012 CCAR disclosed virtually the same amount and detail of bank level stress data as the 2009 SCAP (i.e., bank level loss rates and losses by major asset classes). The regulatory asset classes are:

1. First and second lien mortgages.
2. Commercial and industrial (C&I) loans.
3. Commercial real estate loans.
4. Credit card lending.
5. Other consumer loans.
6. Other loans.

One of the key contributions of the CCAR was that in both 2011 and 2012 the CCAR required banks to submit the results of their own scenarios, both baseline and stress, not just supervisory stress test results. The Fed also reported dollar pre-provision net revenue (PPNR), gains and losses on available-for-sale and held-to-maturity securities, and trading and counterparty losses for the six institutions with the largest trading portfolios. These firms were required to conduct the trading book stress test. The numbers that were reported were supervisory estimates, not bank estimates, of losses under the stress scenario.

In contrast, the 2011 European Banking Authority (EBA) Irish and 2011 EBA European-wide stress tests, both disclosed after the CCAR, contained considerable detail. In the Irish case, the report contained a comparison of bank and third party estimates of losses. The EBA data was available in electronic, downloadable form. Ireland needed credibility, having passed the Committee of European Bank Supervisors (CEBS) stress test in July 2010 only to need considerable aid four months later. In general, the faith in European supervisors was harmed and only by disclosing detailed information on bank-by-bank, asset-class, country, and maturity bucket basis could the market interpret the data and draw its own conclusions about individual bank risks. Figure 2 summarizes the differences among the various stress test regimes.

Figure 2: Comparison of Macro-prudential Stress Tests

Stress Test	*Methodologies*	*Disclosure*	*Findings*
SCAP (2009). All banks with \$100 billion or more in assets as of 2008 year end were included.	Tested simple scenarios with three dimensions, GDP growth, unemployment, and the house price index (HPI). Historical experience was used for the market risk scenario (i.e., the financial crisis—a period of "flight to safety," the failure of Lehman, and higher risk premia). A "one-size-fits-all" approach.	First to provide bank level projected losses and asset/ product level loss rates.	19 SCAP banks were required to raise \$75 billion within six months. The undercapitalized banks actually raised \$77 billion of Tier 1 common equity and none of the banks were forced to use the Treasury's Capital Assistance Program funds.
CCAR (2011)	In recognition of "one-size-fits-all" stress testing, CCAR asked banks to submit results from their own baseline and stress scenarios.	Only macro-scenario results were published.	
CCAR (2012)	Banks were again asked to submit their own baseline and stress test results.	Similar in detail to SCAP 2009— bank level and asset/ product level loss rates disclosed.	
EBA Irish (2011)	Similar in design to EBA Europe 2011.	Comparison of bank and third party projected losses; comparison of exposures by asset class and geography. Data is electronic and downloadable.	After passing the 2010 stress tests, 2011 stress tests revealed Irish banks needed €24 billion. Greater disclosure in 2011 resulted in tightening credit spreads on Irish sovereign and individual bank debt.
EBA Europe (2011). [formerly the Committee of European Bank Supervisors (CEBS)] 90 European banks were stress tested.	Specified eight macro-factors (GDP growth, inflation, unemployment, commercial and residential real estate price indices, short and long-term government rates, and stock prices) for each of 21 countries. Specified over 70 risk factors for the trading book. It also imposed sovereign haircuts across seven maturity buckets.	Bank level projected losses. Comparisons of exposures by asset class and geography. Data is electronic and downloadable.	Eight banks were required to raise €2.5 billion.

The key benefit of greater disclosure is transparency. Transparency is especially important in times of financial distress. However, during "normal" times, the costs of disclosure may outweigh the benefits. For example, banks may "window dress" portfolios, making poor long-term investment decisions to increase the likelihood of passing the test. Traders may place too much weight on the public information included in stress test disclosure and be disincentivized to produce private information about financial institutions. This harms the information content of market prices and makes prices less useful to regulators making policy decisions.

One thing to note is that prior to the CCAR 2011 requirements, all supervisory stress tests imposed the same scenarios on all banks (i.e., a one-size-fits-all approach to stress testing). In recognition of the problem, the 2011 and 2012 CCAR asked banks to submit results from their own scenarios in addition to the supervisory stress scenario in an attempt to reveal bank-specific vulnerabilities.

Key Concepts

LO 56.1

After the 2007–2009 financial crisis, it was clear that traditional risk measures such as regulatory capital ratios were insufficient. Supervisory stress-testing became an important risk-assessment tool at that point.

The goal of stress testing is to assess how much capital and liquidity a financial institution needs to support its business (i.e., risk taking) activities.

The 2009 U.S. bank stress test, known as the Supervisory Capital Assessment Program (SCAP), was the first macro-prudential stress test after the 2007–2009 financial crisis.

Disclosure was a significant feature of the 2009 SCAP. This high level of disclosure lead to transparency and allowed investors and the market the ability to check the severity of the stress tests and the outcomes of the stress at the individual bank level.

In 2011, CCAR required only macro-scenario results be published, not bank level results, differing significantly from the 2009 SCAP requirements. The 2012 CCAR disclosed virtually the same amount and detail of bank level stress data as the 2009 SCAP. The EBA Irish and the EBA Europe required significant disclosures as well. The disclosures were needed to increase trust in the European banking system.

LO 56.2

One of the challenges regulators face is designing coherent stress tests. The sensitivities and scenarios must be extreme but must also be reasonable and possible (i.e., coherent). Problems are inherently multi-factor, making it more difficult to design a coherent stress test.

LO 56.3

Current stress tests are based on macro-scenarios (i.e., unemployment, GDP growth, the HPI). One concern is how to translate the macro-risk factors employed in stress tests into micro (i.e., bank specific) outcomes related to revenues and losses. Supervisors must be able to map from macro-factors into intermediate risk factors that drive losses in specific products and geographic areas.

In a stress model, the starting balance sheet generates the first quarter's income and loss from the stressed scenario, which in turn determines the quarter-end balance sheet. The bank must maintain its capital (and liquidity) ratios during all quarters of the stress test horizon, typically two years.

Concept Checkers

1. Which of the following changes in stress testing was not the result of the 2009 Supervisory Capital Assessment Program (SCAP)?
   A. Banks are now required to provide the results of their own scenario stress tests.
   B. Stress scenarios are now broader in nature.
   C. Stress testing now focuses on the whole firm.
   D. Stress testing now focuses on revenues, costs, and losses.

2. Piper Hook, a bank examiner, is trying to make sense of stress tests done by one of the banks she examines. The stress tests are multi-factored and complex. The bank is using multiple extreme scenarios to test capital adequacy, making it difficult for Hook to interpret the results. One of the key stress test design challenges that Hook must deal with in her examination of stress tests is:
   A. multiplicity.
   B. efficiency.
   C. coherence.
   D. efficacy.

3. Greg Nugent, a regulator with the Office of the Comptroller of the Currency, is presenting research on stress tests to a group of regulators. He is explaining that macro-variable stress testing can be misleading for some banks because of geographical differences in macro risk factors. He gives the example of the wide range of unemployment rates across the U.S. following the 2007–2009 financial crisis. Which type of loan did Nugent most likely identify as having losses tied to unemployment rates?
   A. Residential real estate loans.
   B. Credit card loans.
   C. Commercial real estate loans.
   D. Industrial term loans.

4. A risk modeler has to make assumptions about acquisitions and spinoffs, if dividend payments will change, and if the bank will buy back stock or issue stock options to employees. These factors make it especially challenging to:
   A. get a CAMELS rating of 2 or better.
   B. determine if the bank has enough liquidity to meet its obligations.
   C. meet the Tier 1 equity capital to risk-weighted assets ratio.
   D. model a bank's balance sheet over a stress test horizon.

5. One of the key differences between the 2011 CCAR stress test and the 2011 EBA Irish stress test is that:
   A. the CCAR did not require banks to provide results from their own stress scenarios.
   B. the EBA Irish did not find any banks in violation of capital adequacy requirements.
   C. the CCAR required disclosure of macro-level, not bank level, scenario results.
   D. the EBA Irish allowed for 1-year stress horizons.

Concept Checker Answers

1. **A** The 2009 U.S. bank stress test, known as the Supervisory Capital Assessment Program (SCAP), was the first macro-prudential stress test after the 2007–2009 financial crisis.

   The 2011 CCAR, not the 2009 SCAP, required that banks provide results of their own stress scenarios along with supervisory stress scenarios.

2. **C** One of the challenges of designing useful stress tests is coherence. The sensitivities and scenarios must be extreme but must also be reasonable or possible (i.e., coherent). Problems are inherently multi-factored, making it more difficult to design a coherent stress test. Hook is dealing with the possibly incoherent results of the bank's stress tests.

3. **B** Credit card losses are particularly sensitive to unemployment figures. For example, unemployment was 12.9% in Nevada in July 2011, 3.3% in North Dakota, and the national unemployment rate was 9.1%. Credit card loss rates varied dramatically from region to region during this period. Residential mortgages are affected by unemployment as well but people are generally more likely to quit paying credit card bills before mortgages.

4. **D** In a stress model, the starting balance sheet generates the first quarter's income and loss from the stressed scenario, which in turn determines the quarter-end balance sheet. At that point the person modeling the risk must consider if any assets will be sold or originated, if capital is depleted due to other actions such as acquisitions or conserved as the result of a spin-off, if there are changes made to dividend payments, if shares will be repurchased or issued (e.g., employee stock or stock option programs), and so on. This makes it challenging to model the balance sheet over the stress horizon.

5. **C** The 2011 CCAR required banks to provide results from their own stress scenarios but the EBA Irish did not. After the 2011 EBA Irish tests, €24 billion was required to increase the capital of several banks. The 2011 CCAR, unlike the SCAP and the 2012 CCAR, only required the disclosure of macro-level scenario results. The EBA Irish did not change the stress horizon from two years to one year.

The following is a review of the Operational and Integrated Risk Management principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

Guidance on Managing Outsourcing Risk

Topic 57

Exam Focus

This short and nontechnical topic begins by examining the general risks arising from a financial institution's use of service providers. It then provides details on the key elements of an effective service provider risk management program. For the exam, focus on the three broad areas of due diligence. Also, be familiar with the details from the numerous contract provisions that should be addressed with third-party service providers.

LO 57.1: Explain how risks can arise through outsourcing activities to third-party service providers, and describe elements of an effective program to manage outsourcing risk.

Risks of Outsourcing Activities to Third-Party Service Providers

The following risks could arise when a financial institution outsources its operational functions to third-party service providers:

- **Compliance risk** refers to a service provider not operating in compliance with the relevant local laws and regulations.
- **Concentration risk** refers to having very few service providers to choose from or that the service providers are clustered in only a few geographic areas.
- **Reputational risk** refers to a service provider executing its tasks in a substandard manner, resulting in a negative public perception of the financial institution.
- **Country risk** refers to using a service provider based in a foreign country and subjecting the financial institution to potential economic and political risks in that country.
- **Operational risk** refers to potential losses sustained by a financial institution as a result of internal control breaches and human error caused by a service provider.
- **Legal risk** refers to subjecting the financial institution to lawsuits and other costs due to potentially negligent activities of a service provider.

Effective Program to Manage Outsourcing Risk

The risk management program with service providers needs to contain adequate oversight and controls over activities that have a material impact on the institution's finances and operations. In addition, importance must be placed on activities relating to sensitive customer information and new products and services. The depth and complexity of the program may be relatively low if there are few outsourced activities, and the service providers are established and reliable. Conversely, the depth and complexity may be relatively high if there are many service providers involved in outsourced activities.

Risk management programs should include (1) risk assessments, (2) due diligence in selecting service providers, (3) contract provisions, (4) incentive compensation review, (5) oversight and monitoring of service providers, and (6) business continuity and contingency plans.

The last five elements will be discussed in subsequent sections. The crucial first step is to perform **risk assessments** of the applicable business activities to determine whether these activities are best executed in-house or by a third party. Assuming the outsourcing option is consistent with the financial institution's business objectives, then a cost-benefit analysis and a risk analysis of the service provider should be performed. Two key questions to be answered include the following: (1) Do qualified and experienced service providers exist? (2) Is the financial institution sufficiently qualified to perform oversight duties and manage the relationship with the service provider? Risk mitigation techniques should be updated on a sufficiently regular basis as a result of updated risk assessments.

Due Diligence on Service Providers

LO 57.2: Explain how financial institutions should perform due diligence on third-party service providers.

In performing due diligence on a third-party service provider, a financial institution should involve any relevant technical specialists and/or important stakeholders. The three key areas of review include (1) business background, reputation, and strategy; (2) financial performance and condition; and (3) operations and internal controls. Ultimately, the financial institution must ensure that the service provider follows all relevant laws and regulations in performing services on the institution's behalf.

Business Background, Reputation, and Strategy

There should be a review of the potential service provider's past business history and of its key management personnel. The service provider should provide evidence of an adequate background check system for its new employees.

A review of the service provider's experience, strategy and mission statement, service philosophy, methods of maintaining and improving quality, and company policies is needed. The flexibility and feasibility of the service provider's business model should be evaluated to determine the likelihood of providing services to the financial institution for the long term.

References should be contacted and confirmed, and any licenses and certifications necessary to perform the services should be confirmed. A search for any past or present legal and compliance problems should also be undertaken.

Financial Performance and Condition

The service provider's most recent financial statements (and annual report, if applicable) should be obtained to analyze its assets, liabilities, liquidity, and operating performance for sufficiency. Financial information of any subcontractors should be obtained and analyzed for the same reason. The expected financial impact of the potential contract on the service provider should be determined.

The service provider's long-term survival prospects should be analyzed by considering how long it has been operating as well as its market share growth. Furthermore, its ability to provide the service for the length of the contract in terms of capital and personnel needs to be ascertained. Finally, the amount of insurance coverage and any other issues that may impact the service provider's finances should be considered.

Operations and Internal Controls

The service provider's internal controls, IT systems development and support, IT security systems, and methods of securing confidential information should be evaluated. Additionally, there should be a review of the service provider's staff training, analysis of the service support provided, and confirmation that employee background checks are being performed. Finally, queries should be made about the process involved in maintaining records and any disaster recovery processes in place.

Contract Provisions

LO 57.3: Describe topics and provisions that should be addressed in a contract with a third-party service provider.

Considerations and contract provisions for third-party service providers should include the following elements:

Scope. A contract will state the rights and responsibilities of each party. Examples include (1) contract duration, (2) support, maintenance, and customer service, (3) training of financial institution employees, (4) policies regarding subcontracting, (5) insurance coverage, and (6) policies regarding the use of the financial institution's assets and employees.

Cost and compensation. A contract should indicate the party (or parties) responsible for the payment of any equipment purchases, legal fees, and audit fees pertaining to the service provider's activities. In addition, there should be a listing of all forms of compensation (i.e., fixed, variable, special charges).

Incentive compensation. A contract should include a provision to allow the financial institution to review the appropriateness of incentive compensation (if applicable). Specifically, the service provider may be involved in sales on behalf of the financial institution. Therefore, the incentives should be structured to ensure that the service provider places the interests of the customers (i.e., suitable financial products) over their own interests (i.e., earning higher fees) and to ensure that the service provider does not expose the financial institution to excessive risks.

Right to audit. A contract could optionally contain a provision to allow the financial institution to audit the service provider. It may also require the receipt of various audit reports [e.g., American Institute of Certified Public Accountants (AICPA) Service Organization Control 2 report, Federal Financial Institutions Examination Council (FFIEC) Technology Service Provider examination report] relating to the service provider at stipulated intervals.

Establishment and monitoring of performance standards. A contract should state specific and measurable performance standards (i.e., metrics) with regard to the service provider's work.

Oversight and monitoring. A contract should include a provision requiring the service provider to provide annual financial statements (and the annual report, if applicable) to the financial institution to allow the financial institution to monitor the service provider's ability to continue as a going concern. In addition, a provision should be included to allow the financial institution to increase monitoring and oversight activities when performance deficiencies, control weaknesses, and viability concerns are noted. With regard to higher-risk service providers, a contract could stipulate extra reporting by the service provider or additional monitoring by the financial institution.

Confidentiality and security of information. A contract must contain extensive provisions concerning the confidentiality and security of information pertaining to both the financial institution and its customers. The service provider should only be given such information that is necessary to perform its tasks. Specifically, in the United States, the FFIEC guidance and section 501(b) of the Gramm-Leach-Bliley Act must be followed and should be noted in the contract.

With regard to nonpublic personal information (NPPI) pertaining to the financial institution's customers, a contract should address access, security, and retention of NPPI data by the service provider (if applicable) to comply with privacy laws and regulations. A contract should also require the service provider to give notice to the financial institution of any breaches of data. In that regard, a contract needs to clarify the parties' roles and responsibilities pertaining to NPPI data.

Ownership and license. A contract should state when service providers are permitted to use the financial institution's property (i.e., data and equipment). In addition, clarification is needed regarding the ownership and control of data produced by a service provider. In the event of software purchased from a service provider, it could be necessary to have escrow agreements in place so that the financial institution could access the source code and programs under certain conditions, such as discontinued product support or insolvency of a service provider.

Indemnification. A contract should require the service provider to indemnify (i.e., hold harmless) the financial institution in the event of any legal proceedings arising from the service provider's negligence.

Default and termination. A contract should clarify the types of actions that would constitute a default together with any reasonable remedies that could be undertaken by the financial institution and methods to overcome default by the service provider. In terms of termination, common reasons, such as change in control, poor performance, and nonperformance of duties, should be explained and measured. There should be a provision that requires the service provider to give sufficient notice of termination to the financial institution in the event of a termination by the service provider. Finally, it is important to include provisions detailing the service provider's requirement to return the financial institution's data, records, and any other property.

Dispute resolution. A contract should lay out an agreed-upon dispute resolution plan to resolve disputes quickly and minimize disruption during a dispute.

Limits on liability. A contract may allow for service providers to limit their liability subject to approval by the financial institution's board of directors and management team.

Insurance. A contract should stipulate the requirement of service providers to carry sufficient insurance and provide evidence of coverage. In addition, any significant changes in coverage should be communicated to the financial institution.

Customer complaints. A contract should state which party will deal with customer complaints. If it is the service provider, then they should be required to prepare reports to the financial institution listing the complaints and their status.

Business resumption and contingency plan of the service provider. A contract should detail how the service provider will continue to provide services should a major disaster occur. The focus should be on critical services and any necessary alternative arrangements. Other items, such as backups, disaster recovery and business continuity plans, responsibility for maintaining and testing of such plans, and frequency of testing of such plans, should be included.

Foreign-based service providers. A contract could attempt to provide for the law and regulations of only one jurisdiction (i.e., the financial institution's) to apply for the purposes of contract enforcement and resolution of disputes. This would avoid potentially confusing situations where the foreign laws differ substantially from local laws.

Subcontracting. The subcontractor should be held to the same contract terms in the event that subcontracting is permitted. The contract should explicitly state that the primary service provider is ultimately responsible for all the work performed by the service provider and its subcontractors. The contract should provide a list of acceptable tasks that may be subcontracted and how the primary service provider will supervise and review the subcontractor's work. Finally, the primary service provider's method of performing financial due diligence on the subcontractor should be documented in the contract.

Key Concepts

LO 57.1

The following risks could arise when a financial institution outsources its operational functions to third-party service providers: (1) compliance risk, (2) concentration risk, (3) reputation risk, (4) country risk, (5) operational risk, and (6) legal risk.

An effective program to manage outsourcing risk should include (1) risk assessments, (2) due diligence in selecting service providers, (3) contract provisions, (4) incentive compensation review, (5) oversight and monitoring of service providers, and (6) business continuity and contingency plans.

LO 57.2

In performing due diligence on a third-party service provider, a financial institution should involve any relevant technical specialists and/or important stakeholders. The three key areas of review include (1) business background, reputation, and strategy; (2) financial performance and condition; and (3) operations and internal controls.

LO 57.3

Considerations and provisions that should be addressed in a contract with a third-party service provider include the following: (1) scope, (2) cost and compensation, (3) incentive compensation, (4) right to audit, (5) establishment and monitoring of performance standards, (6) oversight and monitoring, (7) confidentiality and security of information, (8) ownership and license, (9) indemnification, (10) default and termination, (11) dispute resolution, (12) limits on liability, (13) insurance, (14) customer complaints, (15) business resumption and contingency plan of the service provider, (16) foreign-based service providers, and (17) subcontracting.

Concept Checkers

1. Bank Inc., (Bank) operates in the United States and has a service contract in place with Service Co. (Service), which operates in France. Service manages a significant amount of confidential customer data for Bank, and recently a computer glitch at Service resulted in the accidental public disclosure of confidential customer data. As a result of the data breach, which of the following risks is Bank least likely to face?
   A. Compliance risk.
   B. Country risk.
   C. Legal risk.
   D. Operational risk.

2. Which of the following statements regarding risk management programs with service providers to manage outsourcing risk is correct?
   A. The program should focus on business continuity and contingency plans.
   B. The program should contain more detail if there are only a few outsourced activities to established service providers.
   C. The program should contain adequate oversight and controls over all activities that impact the financial institution.
   D. The program should require risk assessments to be updated as a result of updated risk mitigation techniques on a sufficiently regular basis.

3. When performing due diligence on a service provider, ascertaining the sufficiency of its insurance coverage would most appropriately be covered under which of the following categories?
   A. Business background, reputation, and strategy.
   B. Financial performance and condition.
   C. Operations and internal controls.
   D. Oversight and monitoring.

4. The use of performance metrics to assist in determining an acceptable level of performance by a service provider would most appropriately be included in which of the following provisions of a contract with a financial institution?
   A. Customer complaints.
   B. Default and termination.
   C. Indemnification.
   D. Right to audit.

5. Which of the following provisions would a financial institution least likely include in a contract with a third-party service provider?
   A. Establishment and monitoring of performance standards.
   B. Indemnification.
   C. Ownership and license.
   D. Right to audit.

Concept Checker Answers

1. **B** Country risk refers to using a service provider based in a foreign country and subjecting the financial institution to potential economic and political risks in that country. Clearly, it is not a relevant risk arising from the breach of confidential customer data.

   Compliance risk is a possibility given the apparent lack of security controls of the service provider that resulted in the data breach. Operational risk is clearly a relevant risk to the financial institution here given the data breach caused by the service provider. Legal risk is clearly a relevant risk given that the customers affected by the data breach may sue the financial institution as a result of the breach.

2. **A** Unexpected events could result in the inability of the service provider to provide its services to the financial institution. Depending on the nature and importance of the services provided, the financial institution may be exposed to substantial losses as a result of the inability of the service provider to provide its services. Therefore, business continuity and contingency plans should be a key focus in any risk management program with service providers.

   The program should contain *less* detail if there are only a few outsourced activities to established service providers given that the risk to the financial institution would be reduced substantially as a result of the service provider being established. The program should *not* deal with all activities that impact the financial institution but instead focus only on those that have a material impact. The program should require risk mitigation techniques to be updated on a sufficiently regular basis as a result of updated risk assessments.

3. **B** A review of a potential service provider's financial performance and condition would include queries regarding its level of insurance coverage.

   The area of business background, reputation, and strategy takes a more global view of the service provider and would be far less concerned with financial matters such as insurance. Operations and internal controls deal with compliance with relevant laws and regulations, for example, and would be less concerned with financial matters such as insurance. Oversight and monitoring is not an element within the due diligence process, but it is one of the elements (together with due diligence) of an effective risk management program with service providers.

4. **B** With regard to the default and termination provision, common reasons include poor performance and nonperformance of duties, which would be detected through the use of performance metrics. The customer complaints provision deals with which party will deal with customer complaints. The indemnification provision deals with the service provider to indemnify the financial institution in the event of any legal proceedings arising from the service provider's negligence. The right to audit provision deals with allowing the financial institution to audit the service provider.

5. **D** The right to audit provision is optional and is the least important provision of the four listed. The use of performance standards is essential for monitoring and oversight purposes that may result in the determination of default by the service provider and possible termination of the contract. The indemnification provision is important because it deals with the service provider indemnifying (i.e., holding harmless) the financial institution in the event of any legal proceedings arising from the service provider's negligence. The ownership and license provision is crucial because it would state when service providers are permitted to use the financial institution's property (i.e., data and equipment) as well as clarify the ownership and control of data produced by a service provider.

The following is a review of the Operational and Integrated Risk Management principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

Basel I, Basel II, and Solvency II

Topic 58

Exam Focus

This topic provides an overview of the international capital standards put in place by the Basel Committee on Banking Supervision. Basel I (1988) contained the first steps toward risk-weighting bank activities on- and off-balance sheet to relate required capital to risk. Basel I was the first to set a capital to risk-weighted assets requirement, but it only considered credit risk, not market or operational risk. Basel II took a more sophisticated approach to measuring bank credit risk, market risk, and operational risk. For the exam, understand the contribution Basel II makes to risk measurement, and know the differences between the methods used to calculate various risks. Also, know the difference between Basel II and Solvency II, a similar international standard for insurance companies, and the likely repercussions a firm will face if it breaches the standards. In addition, be able to calculate a bank's required capital under the various regimes. One of the recurring themes in this topic is the difference between a standardized approach for measuring risk, used by less sophisticated banks (and insurance companies), and an internal approach that is firm specific and more complex but often lowers required capital because it allows banks to use their own model inputs and considers the correlations between assets.

LO 58.1: Explain the motivations for introducing the Basel regulations, including key risk exposures addressed, and explain the reasons for revisions to Basel regulations over time.

Prior to 1988, bank capital regulations were inconsistent across countries and ignored the riskiness of individual banks. Requirements were stated as minimum ratios of capital to total assets or as maximum ratios of total assets to capital. Some countries and/or regulatory authorities were more diligent in their enforcement of capital regulations than others. As banks became increasingly global, banks operating in countries with more lax standards were perceived to have a competitive advantage over banks operating in countries with strict enforcement of capital regulations.

There were additional problems with the existing regime. First, high risk loans from international banks to lesser developed countries such as Mexico and Brazil raised questions about the adequacy of existing capital to cover potential losses. Second, banks used "accounting games" to record some of these transactions, masking risk. Third, bank transactions were becoming more complex. Off-balance sheet transactions in over-the-counter (OTC) derivatives like interest rate swaps, currency swaps, and options were growing. These off-balance sheet deals did not affect total assets, and thus did not affect the amount of capital a bank was required to keep, providing fuel to the growing belief that total assets did not reflect a bank's total risk. In 1988, the Basel Committee put forth its first guidance to set international risk-based capital adequacy standards, called the 1988 BIS Accord, now commonly known as Basel I.

Basel I

LO 58.2: Explain the calculation of risk-weighted assets and the capital requirement per the original Basel I guidelines.

Basel I put forth two capital requirements:

1. The bank's total assets to capital ratio had to be less than 20 (i.e., capital to total assets had to be greater than 1/20 or 5%). This capital requirement was similar to the requirements in many countries prior to 1988.

2. The bank's on- and off-balance sheet items had to be used to calculate **risk-weighted assets** (RWA). RWA is intended to measure a bank's total credit exposure. The ratio of capital to risk-adjusted assets is called the **Cooke ratio**, after Peter Cooke from the Bank of England. Basel I stipulated that the Cooke ratio must exceed 8%.

Most banks met the first requirement. However, the risk-based capital requirement (i.e., the second requirement) was the key change to capital regulation. The process for calculating risk-weighted assets includes assigning a risk weight that reflects the bank's credit risk exposure, to each of the on- and off-balance sheet items. A sample of some of the risk weights assigned to various asset categories is shown in Figure 1.

Figure 1: Risk Weights for On-Balance Sheet Items

Risk Weight (%)	*Asset Category*
0%	Cash, gold, claims on Organisation of Economic Co-operation and Development (OECD) countries such as U.S. Treasury bonds and insured residential mortgages
20%	Claims on OECD banks and government agencies like U.S. agency securities or municipal bonds
50%	Uninsured residential mortgages
100%	Loans to corporations, corporate bonds, claims on non-OECD banks

Example: Risk-weighted assets

The assets of Blue Star Bank consist of \$20 million in U.S. Treasury bills, \$20 million in insured mortgages, \$50 million in uninsured mortgages, and \$150 million in corporate loans. Using the risk weights from Figure 1, **calculate** the bank's risk-weighted assets.

Answer:

$$(0.0 \times \$20) + (0.0 \times \$20) + (0.5 \times \$50) + (1.0 \times \$150) = \$175 \text{ million}$$

Off-balance sheet items are expressed as a **credit equivalent amount**. The credit equivalent amount is, in essence, the loan principal that is considered to have the same credit risk. This means the bank "converts" off-balance sheet items into on-balance sheet equivalents for the purpose of calculating risk-based capital. The weight is then multiplied by the principal amount (i.e., the credit equivalent amount) of the item to arrive at a risk-weighted value. A **conversion factor** is applied to the principal amount of the instrument for non-derivatives. Off-balance sheet items that are similar, from a credit perspective, to loans (e.g., banker's acceptances), have a conversion factor of 100%. Other off-balance sheet items, such as note issuance facilities, have lower conversion factors.

For interest rates swaps and other over-the-counter (OTC) derivatives, the credit equivalent amount is calculated as:

$$\max(V, 0) + a \times L$$

where:
V = current value of the derivative to the bank
a = add-on factor
L = principal amount

The first term in the equation [max(V, 0)] reflects the bank's current exposure. If the counterparty defaults and *V*, the current value of the derivative, is positive, the bank will lose *V*. If the counterparty defaults and *V* is negative, the exposure is 0 (i.e., no gain or loss to the bank). The **add-on amount** (a × L) allows for the possibility that the bank's exposure may increase in the future. Add-on factors are higher for higher risk derivatives (e.g., longer maturities, riskier underlying assets). A sample of add-on factors is shown in Figure 2.

Figure 2: Add-on Factors as a Percent of Principal for Derivatives

Remaining Maturity in Years	*Interest Rate*	*Exchange Rate and Gold*	*Equity*	*Other Commodities*
< 1 year	0.0	1.0	6.0	10.0
1 to 5 years	0.5	5.0	8.0	12.0
> 5 years	1.5	7.5	10.0	15.0

Example: Credit equivalent amounts for off-balance sheet items

Blue Star Bank has entered a $175 million interest rate swap with a remaining maturity of three years. The current value of the swap is $2.5 million. Using the add-on factors in Figure 2, **calculate** the swap's credit equivalent amount.

Answer:

The add-on factor is 0.5% of the interest rate swap principal.

credit equivalent amount = $2.5 + (0.005 × $175) = $3.375 million

The credit equivalent amount is multiplied by the risk weight for the counterparty to calculate risk-weighted assets. Risk weights are similar to those shown in Figure 1 with the exception of corporate counterparties. If the counterparty is a corporation, the risk weight is 50%. If the counterparty is an OECD bank, the risk weight is 20%.

Example: Calculating risk-weighted assets for an off-balance sheet item

In the previous example, Blue Star Bank entered an interest rate swap that had a credit equivalent amount of $3,375,000. **Calculate** the risk-weighted assets assuming (1) the counterparty is an OECD bank and (2) the counterparty is a corporation.

Answer:

RWA assuming counterparty is an OECD bank: $3,375,000 × 0.2 = $675,000

RWA assuming counterparty is a corporation: $3,375,000 × 0.5 = $1,687,500

The total RWAs of the bank are calculated by summing the on- and off-balance sheet risk-weighted items as follows:

$$\sum_{i=1}^{N} w_i L_i + \sum_{j=1}^{M} w_j C_j$$

where:
w_i = the risk weight of the counterparty of the *i*th on-balance sheet item
L_i = principal of the *i*th on-balance sheet item
w_j = the risk weight of the counterparty of the *j*th off-balance sheet item
C_j = credit equivalent amount of the *j*th off-balance sheet item

The bank must maintain at least 8% capital to risk-weighted assets.

Example: Calculating risk-based capital

Using the information from the previous three examples, **calculate** Blue Star Bank's required capital, assuming the swap counterparty is a corporation.

Answer:

($175 million + $1.6875 million) × 0.08 = $14.135 million

According to Basel I, capital has two components, Tier 1 capital and Tier 2 capital.

Tier 1 capital (or core capital) consists of items such as:

- Equity (subtract goodwill from equity).
- Non-cumulative perpetual preferred stock.

Tier 2 capital (or supplementary capital) consists of items such as:

- Cumulative perpetual preferred stock.
- Certain types of 99-year debentures.
- Subordinated debt with an original maturity greater than five years (where the subordination is to depositors).

Equity capital (i.e., Tier 1) absorbs losses. Supplementary capital (i.e., Tier 2) is subordinate to depositors and thus protects depositors in the event of a bank failure. At least 50% of capital must be Tier 1. This means there is a 4% Tier 1 capital to risk-weighted assets requirement (i.e., 8% × 0.5). Half of the Tier 1 requirement has to be met with common equity. Under Basel I, some countries required banks to have more capital than required by The Accord.

Professor's Note: Basel I had a number of shortcomings that were remedied over the coming years with new capital accords. For example, Basel I treats all corporate loans the same in terms of capital requirements. The creditworthiness of the borrower is ignored. Also, Basel I did not include a model of default correlation.

Market Risk Capital Requirements

LO 58.3: Describe and contrast the major elements—including a description of the risks covered—of the two options available for the calculation of market risk capital:

- **Standardized Measurement Method**
- **Internal Models Approach**

The goal of the **1996 Amendment** to the 1988 Basel Accord was to require banks to measure market risks associated with trading activities and maintain capital to back those risks. Banks must **mark-to-market** (i.e., *fair value accounting*) bonds, marketable equity securities, commodities, foreign currencies, and most derivatives that are held by the bank for the purpose of trading (referred to as the *trading book*). Banks do not have to use fair value accounting on assets they intend to hold for investment purposes (referred to as the *banking book*). This includes loans and some debt securities. The 1996 Amendment proposed two methods for calculating market risk:

1. Standardized Measurement Method.
2. Internal Model-Based Approach.

Standardized Measurement Method. This method assigns a capital charge separately to each of the items in the trading book. It ignores correlations between the instruments. Banks with less sophisticated risk management processes are more likely to use this approach.

Internal Model-Based Approach. This method involves using a formula specified in the amendment to calculate a value at risk (VaR) measure and then convert the VaR into a capital requirement. Capital charges are generally lower using this method because it better reflects the benefits of diversification (i.e., correlations between the instruments). As such, banks with more advanced risk management functions prefer the internal models approach.

Risks covered by the VaR model include movements in broad market variables such as interest rates, exchange rates, stock market indices, and commodity prices.

The VaR model does not incorporate company-specific risks such as changes in a firm's credit spread or changes in a company's stock price. The **specific risk charge** (SRC) captures company-specific risks. For example, a corporate bond has interest rate risk, captured by VaR, and credit risk, captured by the SRC. Tier 3 capital consisting of short-term subordinated, unsecured debt with an original maturity of at least two years could be used to meet the market risk capital requirement at the time of the amendment. Tier 3 capital has subsequently been eliminated under Basel III.

LO 58.4: Calculate VaR and the capital charge using the internal models approach, and explain the guidelines for backtesting VaR.

According to the 1996 Amendment, the market risk VaR is calculated with a 10-trading day time horizon and a 99% confidence level. The market risk capital requirement is calculated as:

$$\max(\text{VaR}_{t-1}, m_c \times \text{VaR}_{avg}) + \text{SRC}$$

where:
VaR_{t-1} = previous day's VaR
VaR_{avg} = the average VaR over the past 60 trading days
m_c = multiplicative factor
SRC = specific risk charge

The multiplicative factor must be at least three, but may be set higher by bank supervisors if they believe a bank's VaR model has deficiencies. This means the capital charge will be the higher of either the previous day's VaR or three times the average of the daily VaR plus a charge for company specific risks (i.e., the SRC).

Banks calculate a 10-day, 99% VaR for SRC. Regulators then apply a multiplicative factor (which must be at least four) similar to m_c to determine the capital requirement. The total capital requirement for banks using the internal model-based approach must be at least 50% of the capital required using the standardized approach.

The bank's total capital charge, according to the 1996 Amendment, is the sum of the capital required according to Basel I, described in LO 58.2, and the capital required based on the 1996 Amendment, described in this LO. For simplicity, the RWAs for market risk capital was defined as 12.5 times the value given in the previous equation. The total capital a bank has to keep under the 1996 Amendment is:

$$\text{total capital} = 0.08 \times (\text{credit risk RWA} + \text{market risk RWA})$$

where:

$$\text{market RWA} = 12.5 \times (\max(\text{VaR}_{t-1}, m_c \times \text{VaR}_{avg}) + \text{SRC})$$

$$\text{credit RWA} = \Sigma(\text{RWA on-balance sheet}) + \Sigma(\text{RWA off-balance sheet})$$

Example: Market risk capital charge

A bank calculates the previous day's market risk VaR as $10 million. The average VaR over the preceding 60 trading days is $8 million. The specific risk charge is $5 million. Assuming a multiplicative factor of three, **calculate** the market risk capital charge.

Answer:

$$\text{market risk capital charge} = 0.08 \times \{12.5 \times [(3 \times \$8 \text{ million}) + \$5 \text{ million}]\}$$
$$= \$29 \text{ million}$$

Backtesting

The 1996 Amendment requires banks to backtest the one-day, 99% VaR over the previous 250 days. A bank calculates the VaR using its current method for each of the 250 trading days and then compares the calculated VaR to the actual loss. If the actual loss is greater than the estimated loss, an **exception** is recorded. The multiplicative factor (m_c) is set based on the number of exceptions. If, over the previous 250 days, the number of exceptions is:

- Less than 5, m_c is usually set equal to 3.
- 5, 6, 7, 8, or 9, m_c is set equal to 3.4, 3.5, 3.65, 3.75, and 3.85, respectively.
- Greater than 10, m_c is set equal to 4.

The bank supervisor has discretion regarding the multiplier. If the exception is due to changes in the bank's positions during that day, the higher multiplier may or may not be used. If the exception is due to deficiencies in the bank's VaR model, higher multipliers are likely to be applied. There is no guidance to supervisors in terms of higher multipliers if an exception is simply the result of bad luck.

Credit Risk Capital Requirements

LO 58.5: Describe and contrast the major elements of the three options available for the calculation of credit risk capital:
- **Standardized Approach**
- **Foundation IRB Approach**
- **Advanced IRB Approach**

LO 58.8: Define in the context of Basel II and calculate the worst-case default rate (WCDR).

Basel II specifies three approaches that banks can use to measure credit risk:

1. Standardized approach.
2. Foundation internal ratings based (IRB) approach.
3. Advanced IRB approach.

The Standardized Approach

The **standardized approach** is used by banks with less sophisticated risk management functions. The risk-weighting approach is similar to Basel I, although some risk weights were changed. Significant changes include:

- OECD status is no longer considered important under Basel II.
- The credit ratings of countries, banks, and corporations are relevant under Basel II. For example, sovereign (country) risk weights range from 0% to 150%, and bank and corporate risk weights range from 20% to 150%.
- Bank supervisors may apply lower risk weights when the exposure is to the country in which the bank is incorporated.
- Bank supervisors may choose to base risk weights on the credit ratings of the countries in which a bank is incorporated rather than on the bank's credit rating. For example, if a sovereign rating is AAA to AA–, the risk weight assigned to a bank is 20%. The risk weight increases to 150% if the country is rated below B– and is 100% if the country's bonds are unrated.
- Risk weights are lower for unrated countries, banks, and companies than for poorly rated countries, banks, and companies.
- Bank supervisors who elect to use the risk weights in Figure 3 are allowed to lower the risk weights for claims with maturities less than three months. For example, the risk weights for short-maturity assets may range from 20% if the rating is between AAA to BBB–or unrated, to 150% if the rating is below B–.
- A 75% risk weight is applied to retail loans, compared to 100% under Basel I. A 100% risk weight is applied to commercial real estate loans. The uninsured residential mortgage risk weights are 35% under Basel II, down from 50% under Basel I.

A sample of risk weights under the standardized approach is presented in Figure 3.

Figure 3: Risk Weights (as a Percent) Under Basel II's Standardized Approach

	AAA to AA–	*A+ to A–*	*BBB+ to BBB–*	*BB+ to BB–*	*B+ to B–*	*Below B–*	*Unrated*
Country	0	20	50	100	100	150	100
Bank	20	50	50	100	100	150	50
Corporation	20	50	100	100	150	150	100

Collateral Adjustments

Banks adjust risk weights for collateral using the **simple approach**, similar to Basel I, or the **comprehensive approach**, used by most banks. Under the simple approach, the risk weight of the collateral replaces the risk weight of the counterparty. The counterparty's risk weight is used for exposure not covered by collateral. Collateral must be revalued at least every six months. A minimum risk weight of 20% is applied to collateral. Using the comprehensive approach, banks adjust the size of the exposure upward and the value of the collateral downward, depending on the volatility of the exposure and of the collateral value.

Example: Adjusting for collateral using the simple approach

Blue Star Bank has a $100 million exposure to Monarch, Inc. The exposure is secured by $80 million of collateral consisting of AAA-rated bonds. Monarch has a credit rating of B. The collateral risk weight is 20% and the counterparty risk weight is 150%. Using the simple approach, **calculate** the risk-weighted assets.

Answer:

$(0.2 \times 80) + (1.5 \times 20) = \$46$ million risk-weighted assets

Example: Adjusting exposure and collateral using the comprehensive approach

Blue Star Bank assumes an adjustment to the exposure in the previous example of +15% to allow for possible increases in the exposures. The bank also allows for a –20% change in the value of the collateral. **Calculate** the new exposure using the comprehensive approach.

Answer:

$(1.15 \times 100) - (0.8 \times 80) = \$51$ million exposure

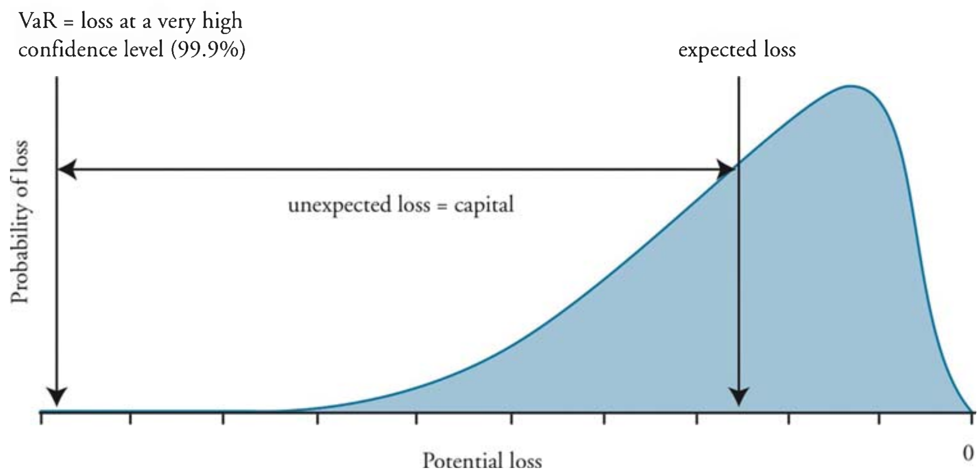
Applying a risk weight of 150% to the exposure:

$1.5 \times 51 = \$76.5$ million risk-weighted assets

The Internal Ratings Based (IRB) Approach

United States regulators applied Basel II to large banks only. As such, regulatory authorities decided that the **IRB approach** must be used by U.S. banks. Under the IRB approach, the capital requirement is based on a VaR calculated over a one-year time horizon and a 99.9% confidence level. The model underlying this approach is shown in Figure 4.

Figure 4: Capital Requirement



The goal of the IRB approach is to capture unexpected losses (UL). Expected losses (EL) should be covered by the bank's pricing (e.g., charging higher interest rates on riskier loans to cover EL). The capital required by the bank is thus VaR minus the bank's EL. The VaR can be calculated using a Gaussian copula model of time to default. That is:

$$\text{WCDR}_i = N\left[\frac{N^{-1}(PD_i) + \sqrt{\rho}N^{-1}(0.999)}{\sqrt{1-\rho}}\right]$$

In this equation, WCDR_i is the **worst case probability of default**. The bank can be 99.9% certain that the loss from the *i*th counterparty will not exceed this amount in the coming year. PD is the one-year **probability of default** of the i^{th} obligor given a large number of obligors, and ρ is the **copula correlation** between each pair of obligors.

Professor's Note: WCDR is called the worst case probability of default in the assigned reading. It is also called the worst case default rate, hence the acronym WCDR.

Assuming the bank has a large portfolio of instruments such as loans and derivatives with the same correlation, the one-year, 99.9% VaR is approximately:

$$\text{VaR}_{99.9\%,\ 1-\text{year}} \approx \sum_i \text{EAD}_i \times \text{LGD}_i \times \text{WCDR}_i$$

EAD_i is the **exposure at default** of the i^{th} counterparty or the dollar amount the i^{th} counterparty is expected to owe if it defaults. For example, if the counterparty has a loan outstanding, EAD would likely be the principal amount outstanding on the loan at the time of default. LGD_i is the **loss given default** for the i^{th} counterparty or the proportion of the EAD_i that is expected to be lost in the event of default. For example, if the bank expected to collect (i.e., recover) 40% in the event of default, the LGD_i would be 60% (i.e., 1 – 0.4 = 0.6).

Recall from Book 2 that the expected loss (EL) from default is computed as:

$$EL = \sum_i EAD_i \times LGD_i \times PD_i$$

The capital the bank is required to maintain is the excess of the worst-case loss over the bank's expected loss defined as follows:

$$\text{required capital} = \sum_i EAD_i \times LGD_i \times (WCDR_i - PD_i)$$

Note that WCDR, PD, and LGD are expressed as decimals while EAD is expressed in dollars.

Figure 5 shows the dependence of the one-year WCDR on PD and correlation, ρ.

Figure 5: Dependence of One-Year, 99.9% WCDR on PD and ρ

	PD = 0.1%	*PD = 0.5%*	*PD = 1%*	*PD = 1.5%*	*PD = 2.0%*
ρ = 0.0	0.1%	0.5%	1.0%	1.5%	2.0%
ρ = 0.2	2.8%	9.1%	14.6%	18.9%	22.6%
ρ = 0.4	7.1%	21.1%	31.6%	39.0%	44.9%
ρ = 0.6	13.5%	38.7%	54.2%	63.8%	70.5%
ρ = 0.8	23.3%	66.3%	83.6%	90.8%	94.4%

It is clear from Figure 5 that WCDR increases as the correlation between each pair of obligors increases and as the probability of default increases. If the correlation is 0, then WCDR is equal to PD.

Basel II assumes a relationship between the PD and the correlation based on empirical research. The formula for correlation is:

$$\rho = 0.12 \times (1 + e^{-50 \times PD})$$

Note that there is an inverse relationship between the correlation parameter and the PD. As creditworthiness declines, the PD increases. At the same time, the PD becomes more idiosyncratic and less affected by the overall market, thus the inverse relationship.

The relationship between WCDR and PD, as shown in Figure 6, is obtained by combining the previous equation with the calculation of WCDR. The WCDR increases as the PD increases, but not as fast as it would if the correlation were assumed to be independent of PD.

Figure 6: Relationship Between WCDR and PD for Firm, Sovereign, and Bank Exposures

PD	0.1%	0.5%	1.0%	1.5%	2.0%
WCDR	3.4%	9.8%	14.0%	16.9%	19.0%

From a counterparty's perspective, the capital required for the counterparty incorporates a maturity adjustment as follows:

$$\text{required capital} = \text{EAD} \times \text{LGD} \times (\text{WCDR} - \text{PD}) \times \text{MA}$$

where:
MA = maturity adjustment = $(1 + (M - 2.5) \times b)/(1 - 1.5 \times b)$
M = maturity of the exposure
b = $[0.11852 - 0.05478 \times \ln(\text{PD})]^2$

The **maturity adjustment**, MA, allows for the possibility of declining creditworthiness and/or the possible default of the counterparty for longer term exposures (i.e., longer than one year). If M = 1.0, then MA = 1.0 and the maturity adjustment has no impact. The risk-weighted assets are calculated as 12.5 times capital required:

$$\text{RWA} = 12.5 \times [\text{EAD} \times \text{LGD} \times (\text{WCDR} - \text{PD}) \times \text{MA}]$$

The capital required is 8% of RWA. The capital required should be sufficient to cover unexpected losses over a one-year period with 99.9% certainty (i.e., the bank is 99.9% certain the unexpected loss will not be exceeded). Expected losses should be covered by the bank's product pricing. Theoretically, the WCDR is the probability of default that happens once every 1,000 years. If the Basel Committee finds the capital requirements too high or too low, it reserves the right to apply a scaling factor (e.g., 1.06 or 0.98) to increase or decrease the required capital.

Professor's Note: On the exam, if you begin with RWA, multiply by 0.08 to get the capital requirement. If instead you begin with the capital requirement, multiply by 12.5 (or divide by 0.08) to get RWA. In other words, these percentages are simply reciprocals (i.e., 1/0.08 = 12.5).

Foundation IRB Approach vs. Advanced IRB Approach

The **foundation IRB approach** and the **advanced IRB approach** are similar with the exception of who provides the estimates of LGD, EAD, and M. The key differences between the two approaches are outlined by the following.

Foundation IRB Approach

- The bank supplies the PD estimate. For bank and corporate exposures, there is a 0.03% floor set for PD.
- The LGD, EAD, and M are supervisory values set by the Basel Committee. The Basel Committee set LGD at 45% for senior claims and 75% for subordinated claims. If there is collateral, the LGD is reduced using the comprehensive approach described earlier.
- The EAD is calculated similar to the credit equivalent amount required under Basel I. It includes the impact of netting.
- M is usually set to 2.5.

Advanced IRB Approach

- Banks supply their own estimates of PD, LGD, EAD, and M.
- PD can be reduced by credit mitigants such as credit triggers subject to a floor of 0.03% for bank and corporate exposures.
- LGD is primarily influenced by the collateral and the seniority of the debt.
- With supervisory approval, banks can use their own estimates of credit conversion factors when calculating EAD.

Foundations IRB Approach and Advanced IRB Approach for Retail Exposures

- The two methods are merged for retail exposures. Banks provide their own estimates of PD, EAD, and LGD.
- There is no maturity adjustment (MA) for retail exposures.
- The capital requirement is EAD × LGD × (WCDR – PD).
- Risk-weighted assets are 12.5 × EAD × LGD × (WCDR – PD).
- Correlations are assumed to be much lower for retail exposures than for corporate exposures.

Example: RWA under the IRB approach

Assume Blue Star Bank has a $150 million loan to an A-rated corporation. The PD is 0.1% and the LGD is 50%. Based on Figure 6, the WCDR is 3.4%. The average maturity of the loan is 2.5 years. **Calculate** the RWA using the IRB approach and compare it to the RWA under Basel I.

Answer:

$$b = [0.11852 - 0.05478 \times \ln(0.001)]^2 = 0.247$$

$$\text{MA} = 1/\ (1 - (1.5 \times 0.247)) = 1.59$$

$$\text{risk-weighted assets} = 12.5 \times 150 \times 0.5 \times (0.034 - 0.001) \times 1.59 = \$49.19 \text{ million}$$

Under Basel I, the RWA for corporate loans was 100% or $150 million in this case. Thus, the IRB approach lowers the RWA for higher rated corporate loans, in this case from $150 million to $49.19 million.

Operational Risk Capital Requirements

LO 58.6: Describe and contrast the major elements of the three options available for the calculation of operational risk capital: basic indicator approach, standardized approach, and the Advanced Measurement Approach.

Basel II requires banks to maintain capital for operational risks. Operational risks include failures of the bank's procedures that result in loss (e.g., fraud, losses due to improper trading activities). External events that result in loss, such as a fire, are also considered operational risks.

Under Basel II, there are three approaches banks may use to calculate capital for operational risk:

1. Basic indicator approach.
2. Standardized approach.
3. Advanced measurement approach.

Basic Indicator Approach (BIA). This is the simplest approach and is used by banks with less sophisticated risk management functions. The required capital for operational risk is equal to the bank's average annual gross income (i.e., net interest income plus non-interest income) over the last three years multiplied by 0.15.

The Standardized Approach (TSA). This method is similar to the basic indicator approach. The primary difference between the two approaches is that a different multiplier is applied to the bank's gross income for different lines of business.

Advanced Measurement Approach (AMA). Like the IRB approach discussed for credit risk, the capital requirement for operational risk under the advanced measurement approach is based on an operational risk loss (i.e., VaR) calculated over a one-year time horizon with a 99.9% confidence level. The approach has an advantage in that it allows banks to consider risk mitigating factors such as insurance contracts (e.g., fire insurance).

Professor's Note: While Basel II generally lowered credit risk capital requirements for most banks, requiring banks to hold capital for operational risks had the effect of raising overall capital requirements back to (approximately) Basel I levels.

Basel II Pillars of Sound Bank Management

LO 58.7: Describe the key elements of the three pillars of Basel II: minimum capital requirements, supervisory review, and market discipline.

While Basel I improved the way capital requirements were determined for banks worldwide, it had some major limitations. First, all corporate loans were treated the same (i.e., a risk

weight of 100%) regardless of the creditworthiness of the borrower. A firm with an AAA credit rating was treated the same as a borrower with a C rating. Basel I also ignored the benefits of diversification (i.e., there was no model of default correlation). Basel II, proposed in June 1999 and after multiple revisions was published in 2004 and implemented in 2007, corrected a number of the deficiencies in Basel I. The rules applied to "internationally active" banks and thus many small regional banks in the United States were not subject to the requirements but fell under Basel IA, similar to Basel I, instead. All European banks are regulated under Basel II.

There are three pillars under Basel II: (1) minimum capital requirements, (2) supervisory review, and (3) market discipline.

Pillar 1: Minimum Capital Requirements

The key element of Basel II regarding capital requirements is to consider the credit ratings of counterparties. Capital charges for market risk remained unchanged from the 1996 Amendment. Basel II added capital charges for operational risk. Banks must hold total capital equal to 8% of risk-weighted assets under Basel II, as under Basel I. Total capital under Basel II is calculated as:

$$\text{total capital} = 0.08 \times (\text{credit risk RWA} + \text{market risk RWA} + \text{operational risk RWA})$$

Pillar 2: Supervisory Review

Basel II is an international standard, governing internationally active banks across the world. A primary goal of Basel II is to achieve overall consistency in the application of capital requirements. However, Pillar 2 allows regulators from different countries some discretion in how they apply the rules. This allows regulatory authorities to consider local conditions when implementing rules. Supervisors must also encourage banks to develop better risk management functions and must evaluate bank risks that are outside the scope of Pillar 1, working with banks to identify and manage all types of risk.

Pillar 3: Market Discipline

The goal of Pillar 3 is to increase transparency. Banks are required to disclose more information about the risks they take and the capital allocated to these risks. The key idea behind Pillar 3 is that if banks must share more information with shareholders (and potential shareholders), they will make better risk management decisions. Banks have discretion in determining what is relevant and material and thus what should be disclosed. According to Basel II, banks should disclose:

- The entities (banks and other businesses such as securities firms in Europe) to which Basel II rules are applied.
- A description of the characteristics, terms, and conditions of all the capital instruments held by the bank.
- A list of the instruments comprising the bank's Tier 1 capital. The amount of capital provided by each instrument should also be disclosed.
- A list of the instruments comprising the bank's Tier 2 capital.

- The capital requirements for each type of risk covered under Basel II: credit, market, and operational risks.
- Information about other bank risks.
- Information about the bank's risk management function, how it is structured, and how it operates.

Solvency II Framework

LO 58.9: Differentiate between solvency capital requirements (SCR) and minimum capital requirements (MCR) in the Solvency II framework, and describe the repercussions to an insurance company for breaching the SCR and MCR.

There are no international standards to regulate insurance companies. In Europe, Solvency I establishes capital requirements for the underwriting risks of insurance companies. Solvency II is expected to replace Solvency I and will consider operational and investment risks in addition to underwriting risks. While Solvency II was expected to be implemented in 2013, the date has been postponed. Solvency II has three pillars, analogous to Basel II.

Pillar 1 specifies a **solvency capital requirement** (SCR). The SCR may be calculated using the standardized approach or the internal models approach (discussed in the next LO). Repercussions for breaching the SCR are less severe than if the firm breaches a minimum capital requirement (MCR). If the SCR falls below the required level, the insurance company will likely be required to submit a plan for restoring the capital to the required amount. Specific measures, determined by regulators, may be required.

Pillar 1 also specifies a **minimum capital requirement** (MCR), which is an absolute minimum of capital. There are at least two methods for calculating the MCR under consideration. First, MCR may be set as a percentage of the SCR. A second possibility is to calculate MCR the same way as SCR, but with a lower confidence level. The repercussions for breaching the MCR are severe. If a firm's capital falls below the MCR, regulators will likely prohibit the company from taking new business. Regulators can also force the insurance company into liquidation and transfer the company's insurance policies to another firm.

LO 58.10: Compare the standardized approach and the Internal Models Approach for calculating the SCR in Solvency II.

The two approaches an insurance firm can use to calculate the SCR under Solvency II are:

1. Standardized approach.

2. Internal models approach.

Standardized Approach. Analogous to Basel II, the standardized approach to calculating SCR under Solvency II is intended for less sophisticated insurance firms that cannot or do not want to develop their own firm-specific risk measurement model. It is intended to capture the risk profile of the average firm and is more cost efficient for smaller firms with less fully developed risk management functions.

Internal Models Approach. This approach is similar to the IRB approach under Pillar 1 of Basel II. A VaR is calculated with a one-year time horizon and a 99.5% confidence level. There is a capital charge for the following three types of risk:

1. *Underwriting risk*: divided into risks arising from life insurance, non-life insurance (such as property and casualty insurance), and health insurance.

2. *Investment risk*: divided into market risk and credit risk.

3. *Operational risk*.

Regulators have implemented quantitative impact studies (QISs) to examine whether capital is sufficient to weather significant market events. For example, QISs have considered large declines (i.e., 32%) in global stock markets, large declines (20%) in real estate prices, large increases (10%) or decreases (25%) in mortality rates, and so on.

Internal models developed by insurance companies must satisfy the following three tests:

1. **Statistical quality test**: This tests the quality of the data and the methodology the firm uses to calculate VaR.

2. **Calibration test**: This tests whether risks are measured in agreement with an industry-wide SCR standard.

3. **Use test**: This test determines if the model is relevant and used by risk managers.

Key Concepts

LO 58.1

Prior to 1988, bank capital regulations were inconsistent across countries and ignored the riskiness of individual banks. In 1988, the Basel Committee put forth its first guidance to set international risk-based capital adequacy standards known as Basel I.

Basel I was originally developed to cover credit risk capital requirements. It was amended in 1996 to also include market risk capital requirements. Basel II was introduced in 2004 and addressed not only credit and market risk capital but also operational risk capital.

LO 58.2

Under Basel I, banks calculated risk-weighted assets for on- and off-balance sheet items. Capital was required as a percentage of risk-weighted assets. For example, cash and Treasury securities received a 0% risk weight while commercial loans received a 100% risk weight. Off-balance sheet items were expressed as credit equivalent amounts and were "converted" into risk-weighted assets. Capital could be Tier 1 or Tier 2 but at least half of the capital requirement (4%) had to be met with Tier 1 capital (equity and non-cumulative perpetual preferred).

LO 58.3

Banks were required to measure market risk in addition to credit risk under the 1996 Amendment to the 1988 Basel Accord. The 1996 Amendment proposed two methods for calculating market risk including the standardized measurement method and the internal model-based approach. The standardized method assigns a capital charge separately to each of the items in the trading book. This method ignores correlations between the instruments. The internal model-based approach uses a formula specified in the amendment to calculate a value at risk (VaR) measure used to determine the capital requirement. Capital charges are generally lower using this method because it considers correlations between the instruments.

LO 58.4

According to the 1996 Amendment, the market risk VaR is calculated with a 10-trading-day time horizon and a 99% confidence level. The capital requirement for market risk is:

$$\max(\text{VaR}_{t-1}, m_c \times \text{VaR}_{avg}) + \text{SRC}$$

where:
VaR_{t-1} = previous day's VaR
VaR_{avg} = the average VaR over the past 60 days
m_c = multiplicative factor, minimum value of three
SRC = specific risk charge

The 1996 Amendment requires banks to backtest the one-day, 99% VaR over the previous 250 days. If the actual loss is greater than the estimated loss, an exception is recorded. The

multiplicative factor (m_c) is set based on the number of exceptions. If, over the previous 250 days, the number of exceptions is:

- Less than 5, m_c is usually set equal to three.
- 5, 6, 7, 8, or 9, m_c is set equal to 3.4, 3.5, 3.65, 3.75, and 3.85, respectively.
- Greater than 10, m_c is set equal to four.

The bank supervisor has discretion regarding the multiplier.

LO 58.5

Basel II improves on Basel I in at least two ways. First, counterparty credit ratings are considered in calculating risk-weighted assets. Second, a model of default correlation is included. Basel II specifies three approaches banks can use to measure credit risk, including the standardized approach, the foundation internal ratings based (IRB) approach, and the advanced IRB approach. The standardized approach is the least complicated and the risk-weighting approach is similar to Basel I, although some risk weights were changed. Under the IRB approach, the capital requirement is based on a VaR calculated over a one-year time horizon and a 99.9% confidence level. The foundation IRB approach and the advanced IRB approach are similar. The key difference is who supplies the input variables. Banks supply their own estimates of probability of default (PD), loss given default (LGD), exposure at default (EAD), and the maturity adjustment (M) if using the advanced approach. Under the foundation approach, banks supply PD estimates, while the Basel Committee supplies the estimates of LGD, EAD, and M.

LO 58.6

Basel II requires banks to maintain capital for operational risks. Operational risks include failures of the bank's procedures that result in loss (e.g., fraud, losses due to improper trading activities). External events that result in loss, such as a fire that destroys bank assets or information, are also considered operational risks. Under Basel II, there are three approaches banks may use to calculate capital for operational risk including the basic indicator approach (the simplest), the standardized approach (similar to the basic indicator approach but with different multipliers applied to different lines of business), and the advanced measurement approach (the most complex). The capital requirement for operational risk under the advanced measurement approach is based on an operational risk loss calculated over a one-year time horizon and a 99.9% confidence level (i.e., VaR). The approach has an advantage in that it allows banks to consider risk mitigating factors such as insurance contracts.

LO 58.7

Basel II is an international standard, governing "internationally active banks." There are three pillars under Basel II as follows:

1. Minimum capital requirements. This pillar involves calculating capital based on the riskiness of the bank, taking into consideration credit risk, market risk, and operational risk.

2. Supervisory review. A primary goal of Basel II is to achieve overall consistency in the application of the capital requirements across countries while, at the same time, giving supervisors discretion to consider market conditions in their own countries.

3. Market discipline. Banks are required to disclose more information about the risks they take and the capital allocated to those risks. According to Basel II, if banks must share more information with shareholders (and potential shareholders), they will make better risk management decisions.

LO 58.8

In the context of Basel II, the worst case probability of default (WCDR) is the amount the bank can be 99.9% certain the loss will not exceed (from a specific counterparty) in the coming year. The one-year probability of default (PD) is the probability that an obligor, given a large number of obligors, will default. The exposure at default (EAD) is the dollar amount a counterparty is expected to owe if it defaults. The loss given default (LGD) is the proportion of the EAD that is expected to be lost in the event the counterparty defaults. For example, if the bank expected to collect 40% in the event of default by a counterparty, the LGD is 60%.

LO 58.9

In Europe, Solvency I establishes capital requirements for the underwriting risks of insurance companies. Solvency II is expected to replace Solvency I and will consider operational and investment risks in addition to underwriting risks. Pillar 1 of Solvency II specifies:

- Minimum capital requirement (MCR). The repercussions for breaching the MCR will likely include a prohibition from taking new business. Regulators may also force the insurance company into liquidation and transfer the company's insurance policies to another firm.
- Solvency capital requirement (SCR). Repercussions for breaching the SCR are less severe than if the firm breaches the MCR. If the SCR falls below the required level, the insurance company will likely be required to submit a plan for restoring the capital to the required amount.

LO 58.10

There are two approaches an insurance firm can use to calculate the SCR under Solvency II. They are the standardized approach and the internal models approach. The standardized approach is least complicated and is meant to capture the risk of the average firm. The internal models approach is similar to the IRB approach under Basel II. It involves calculating a VaR with a one-year time horizon and a 99.5% confidence level.

Concept Checkers

1. Michigan One Bank and Trust has entered a $200 million interest rate swap with a corporation. The remaining maturity of the swap is six years. The current value of the swap is $3.5 million. Using the table below to find the add-on factor for the interest rate swap, the equivalent risk-weighted assets (RWA) under Basel I is closest to:

Add-on Factors as a Percentage of Principal for Derivatives

Remaining Maturity in Years	*Interest Rate*	*Equity*
< 1 year	0.0	6.0
1 to 5 years	0.5	8.0
> 5 years	1.5	10.0

A. $3,000,000.
B. $3,250,000.
C. $3,500,000.
D. $6,500,000.

2. Saugatuck National Bank uses the internal model-based approach to set market risk capital as prescribed by the 1996 Amendment to the 1988 Basel Accord. The bank has backtested its 99%, one-day VaRs against the actual losses over the last 250 trading days. Based on the results of the backtesting, the bank recorded 11 exceptions. Based on these results, the multiplicative factor (m_c) in the model should be set:
A. less than 3.
B. equal to 3.
C. between 3.1 and 3.9.
D. equal to 4.

3. Bank Macatawa has a $150 million exposure to Holland Metals Co. The exposure is secured by $125 million of collateral consisting of AA+-rated bonds. Holland Metals Co. is unrated. The collateral risk weight is 20%. Bank Macatawa assumes an adjustment to the exposure of +15% to allow for possible increases in the exposure and allows for a –25% change in the value of the collateral. Risk-weighted assets for the exposure are closest to:
A. $78.75 million.
B. $93.75 million.
C. $118.13 million.
D. $172.50 million.

4. Which of the following accords first required banks to hold capital for operational risk?
A. Basel I.
B. The 1996 Amendment to Basel I.
C. Basel II.
D. Solvency II.

5. Which of the following statements is correct regarding capital requirements for insurance companies?
   A. Basel II includes the regulation of banks and insurance companies in the three pillars.
   B. The minimum capital requirement is likely to be higher than the solvency capital requirement for insurance companies.
   C. The repercussion for violating the solvency capital requirement is likely liquidation and the transfer of company insurance policies to another firm.
   D. The internal models approach to calculating the solvency capital requirement is similar to internal ratings based approach under Basel II in that the firm must calculate a VaR with a one-year time horizon.

Concept Checker Answers

1. **B** The add-on factor is 1.5% of the interest rate swap principal for swaps with a maturity greater than five years.

   credit equivalent amount = max(V,0) + a × L

   where:
   V = current value of the derivative to the bank
   A = add-on factor
   L = principal amount

   credit equivalent amount = \$3.5 + (0.015 × \$200) = \$6,500,000

   The risk-weight factor for a corporate counterparty under Basel I is 50% for derivatives and 100% for corporate loans. This means the risk-weighted assets (RWA) are:

   RWA = 0.50 × \$6,500,000 = \$3,250,000

2. **D** Saugatuck National Bank must compare the VaR calculated using its current method for each of the 250 trading days to the actual loss over the same period to determine the multiplicative factor. If the actual loss is greater than the estimated loss, an exception is recorded. If, over the previous 250 days, the number of exceptions is:
   - Less than 5, m_c is usually set equal to three.
   - 5, 6, 7, 8, or 9, m_c is set equal to 3.4, 3.5, 3.65, 3.75, and 3.85, respectively.
   - Greater than 10, m_c is set equal to four.

   Therefore, with 11 exceptions recorded, m_c should be set equal to four.

3. **A** Exposure = (1.15 × 150) – (0.75 × 125) = 172.5 – 93.75 = \$78.75

   The risk weight for an unrated corporate counterparty based on Figure 3 in the topic is 100%. Applying the 100% risk weight, risk-weighted assets are:

   risk-weighted assets = 1.0 × 78.75 = \$78.75 million

4. **C** Basel II requires banks to maintain capital for operational risks. Banks can use three methods to measure operational risk. They are the basic indicator approach, the standardized approach, and the advanced measurement approach.

5. **D** Solvency II, not Basel II, establishes capital requirements for insurance companies. The minimum capital requirement (MCR) is just that, a true floor and is thus likely to be lower than the solvency capital requirement (SCR). The repercussion for violating the MCR is likely the prohibition of taking new business and possible liquidation. The repercussion for violating the SCR is the requirement of a plan to remedy the situation and bring the capital back to the required level. The internal models approach is similar to the internal ratings based approach under Basel II in that the insurance company must calculate a one-year VaR with a 99.5% confidence level (versus 99.9% confidence for banks under Basel II).

The following is a review of the Operational and Integrated Risk Management principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

Basel II.5, Basel III, and Other Post-Crisis Changes

Topic 59

Exam Focus

Following the 2007–2009 financial crisis, the Basel Committee on Banking Supervision implemented reforms to shore up bank capital. This topic describes the measures taken in Basel II.5 and Basel III to increase capital and tighten the definition of what constitutes capital in normal periods, create buffers to protect banks against loss in stress periods, and encourage banks to better manage liquidity risks by requiring banks to maintain liquidity coverage and net stable funding ratios. It also describes the major reforms in the Dodd-Frank Act that impact banks and bank regulation. For the exam, know the major changes to capital regulation, including the incremental risk charge, the comprehensive risk measure, the stressed VaR, the capital conservation buffer, and the countercyclical buffer. Understand why banks may use less mainstream funding sources, such as contingent convertible bonds, as a result of higher capital requirements. In addition, be able to calculate the leverage ratio, liquidity coverage ratio, and net stable funding ratio given a bank's balance sheet. Finally, be able to recognize and describe major changes imposed on U.S. banks by Dodd-Frank, including the creation of the Financial Stability Oversight Council, the Office of Financial Research, and the Bureau of Financial Protection.

Stressed VaR

LO 59.1: Describe and calculate the stressed VaR measure introduced in Basel 2.5, and calculate the market risk capital charge.

The implementation of Basel II coincided with the financial crisis of 2007–2009. Some people blamed Basel II because banks using the advanced internal ratings based (IRB) approach to calculate credit risk were allowed to use their own estimates of probability of default (PD), loss given default (LGD), and exposure at default (EAD). Some believed Basel II was a move toward self-regulation and allowed banks to underestimate risks. As a result, the Basel Committee on Banking Supervision implemented a series of changes to the calculation of market risk capital. These changes were part of Basel II.5, implemented December 31, 2011. There were three primary changes, including:

1. The calculation of a stressed value-at-risk (SVaR).
2. The implementation of a new incremental risk change (IRC).
3. A comprehensive risk measure (CRM) for instruments sensitive to correlations between default risks of various instruments.

In the past, banks used the historical simulation method to calculate the VaR in order to find the market risk capital charge. The assumption in the historical simulation method

is that percentage changes in market variables the next day are random samples of the percentage changes over the previous one to four years. Volatilities of most market variables were low in the pre-crisis period (i.e., 2003–2006). As such, market risk VaRs were also low during this period and continuing for a time following the start of the financial crisis. To remedy the problem of low VaRs, Basel II.5 required banks to calculate two VaRs, the usual VaR, using the historical simulation method, and a **stressed VaR**, using a 250-day period of stressed market conditions. Initially, regulators thought the year 2008 would be ideal for stressed market conditions. However, banks are now required to identify a one-year period when their actual portfolios performed poorly. This means the stressed period may be different across banks.

The total market risk capital charge is the sum of the usual bank VaR and the stressed VaR. The formula for the total capital charge is:

$$\max(VaR_{t-1}, m_c \times VaR_{avg}) + \max(SVaR_{t-1}, m_s \times SVaR_{avg})$$

where:

VaR_{t-1} = previous day's VaR, 10-day time horizon, 99% confidence level
VaR_{avg} = the average VaR over the past 60 days, 10-day time horizon, 99% confidence level
m_c = multiplicative factor, determined by supervisor, minimum value of three
$SVaR_{t-1}$ = previous day's stressed VaR, 10-day time horizon, 99% confidence level
$SVaR_{avg}$ = the average stressed VaR over the past 60 days, 10-day time horizon, 99% confidence level
m_s = stressed VaR multiplicative factor, determined by supervisor, minimum of three

Example: Total market risk capital charge

Spartan State Bank has calculated a market risk VaR for the previous day equal to \$15.6 million. The average VaR over the last 60 days is \$4.8 million. The bank has calculated a stressed VaR for the previous day equal to \$17.7 million and an average stressed VaR equal to \$18.4 million. Spartan State Bank has an accurate risk measurement model and recorded only two exceptions while backtesting actual losses against the calculated VaR. As such, the multiplicative factors, both m_c and $m_{s,}$ are set to 3. **Calculate** the total market risk capital charge.

Answer:

total capital charge = \$15.6 million + (\$18.4 × 3) = \$70.8 million

Professor's Note: Because the stressed VaR will be equal to or, more likely, greater than, VaR, the capital charge for market risk under Basel II.5 will be at least double the capital charge under Basel II.

Incremental Risk Capital Charge

LO 59.2: Explain the process of calculating the incremental risk capital charge for positions held in a bank's trading book.

Prior to the financial crisis, the capital charge for exposures in the bank's trading book (i.e., bonds, marketable equity securities, commodities, foreign currencies, and most derivatives that are held by the bank for the purpose of trading) was generally lower than the capital charge for exposures in the banking book (i.e., instruments the bank intends to hold for investment purposes including loans and some debt securities). A one-year, 99.9% confidence level VaR was required for calculating capital for the banking book while a multiplier was applied to a 10-day, 99% VaR for capital to back the trading book.

The Basel Committee proposed an **incremental default risk charge** (IDRC) in 2005 to correct the problem. The proposal required a 99.9% confidence level, one-year time horizon VaR for instruments in the trading book that are sensitive to default risk. This change had the affect of requiring roughly the same capital for trading book instruments as banking book instruments. However, because much of the 2007–2009 losses in the financial sector were due not to defaults but instead to downgrades, widening credit spreads, and losses of liquidity, the Basel Committee revised the IDRC to become an **incremental risk charge** (IRC). Instead of instruments sensitive to default, it is now credit-sensitive instruments. Banks must consider ratings change sensitivities in addition to default sensitivity. Banks are expected to rebalance the portfolio through the year to lessen default risk.

As part of the IRC calculation, banks are required to estimate a liquidity horizon for each instrument in the portfolio. For example, assume an AA-rated bond in the portfolio has a liquidity horizon of 6 months. If at the end of 6 months the bond has defaulted or has been downgraded, it is assumed that the bank will replace the bond with an AA-rated bond comparable to the one held at the start of the period. This rebalancing is assumed at the end of each six-month period (or three months, nine months, etc., depending on the estimated liquidity horizon). The Basel Committee set the minimum liquidity horizon at three months.

This assumption of rebalancing to the beginning of the period position is known as the **constant level of risk** assumption. Small losses occur as bonds are downgraded and the portfolio is rebalanced, but the likelihood of default is lessened. Generally this assumption reduces the one-year, 99.9% VaR. As discussed in the previous topic, the specific risk charge (SRC) captures changing credit spreads.

Comprehensive Risk Measure

LO 59.3: Describe the comprehensive risk measure (CRM) for positions that are sensitive to correlations between default risks.

The **comprehensive risk measure** (CRM) is a single capital charge for correlation-dependent instruments that replaces the **specific risk charge** (SRC) and the IRC. The measure accounts for risks in the "correlation book." Instruments that are sensitive to the correlation between the default risks of different assets include asset-backed securities (ABS)

and collateralized debt obligations (CDOs). In normal periods, there is little risk of loss for highly rated tranches of these instruments. However, in times of stress, as in the 2007–2009 financial crisis, correlations with other instruments increase and even the highest-rated tranches can be vulnerable to loss.

The committee has specified a standardized approach for rated instruments. Due to the experience of the financial crisis, *resecuritizations*, such as CDOs of ABSs, have higher capital requirements than normal securitizations such as mortgage-backed securities.

Figure 1: Standardized Capital Charge for Correlation-Dependent Instruments

Type of Instrument	*AAA to AA–*	*A+ to A–*	*BBB+ to BBB–*	*BB+ to BB–*	*Below BB– or Unrated*
Securitization	1.6%	4%	8%	28%	Deduction
Resecuritization	3.2%	8%	18%	52%	Deduction

For unrated instruments or instruments rated below BB–, the bank must deduct the principal amount of the exposure from capital. This is equivalent to a 100% capital charge; banks must hold dollar-for-dollar capital against the tranche. For unrated tranches banks are allowed, with supervisory approval, to use an internal model to calculate the CRM. If a bank is allowed to use an internal model, it must routinely perform rigorous stress tests. Internal models must be sophisticated and capture the cumulative effects of several factors including:

- Credit spread risk.
- Multiple defaults.
- The volatility of implied correlations.
- The relationship between implied correlations and credit spreads.
- The costs of rebalancing hedges.
- The volatility of recovery rates.

The Dodd-Frank Wall Street Reform and Consumer Protection Act (Dodd-Frank) does not allow ratings to be used in setting capital requirements. As such, the United States is trying to devise its own CRM rules that do not use ratings.

Professor's Note: For unrated and low rated (below BB–) instruments or tranches, the deduction of the principal amount of the exposure from capital is in essence assigning a 1250% risk weight to the asset class. Think about a \$100 corporate loan that has a 100% risk weight. The capital charge is \$8, or \$100 × 100% × 0.08 (the asset value times the risk weight times the capital requirement). If instead you have a \$100 unrated ABS CDO, the capital charge is \$100. Another way to look at it is \$100 × 1250% × 0.08. This lets you see the difference in the way that these low or unrated correlation dependent instruments are treated in terms of capital requirements, compared to traditional assets like loans.

Basel III Capital Requirements

LO 59.4: Define in the context of Basel III and calculate where appropriate:
- **Tier 1 capital and its components**
- **Tier 2 capital and its components**
- **Required Tier 1 equity capital, total Tier 1 capital, and total capital**

Basel III increased capital for credit risk and tightened the definition of capital in response to the 2007–2009 financial crisis. The proposals were published in December 2010 and will be implemented gradually between 2013 and 2019. Basel III eliminated Tier 3 capital.

Tier 1 capital (or core capital) includes:

- Common equity including retained earnings (called Tier 1 equity capital or Tier 1 common capital).
- Non-cumulative perpetual preferred stock (additional Tier 1 capital, part of total Tier 1 capital).

Tier 1 capital does not include:

- Goodwill.
- Deferred tax assets.
- Changes in retained earnings arising from securitized transactions.
- Changes in retained earnings arising from the bank's credit risk, called debit (debt) value adjustment (DVA).

Tier 1 capital is adjusted downward to reflect defined benefit pension plan deficits (but is not adjusted upward for surpluses). In addition, there are rules governing capital issued by consolidated subsidiaries and also for the inclusion of minority interests.

Tier 2 capital (or supplementary capital) includes:

- Debt subordinated to depositors with an original maturity of five years or more.
- Some preferred stock, such as cumulative perpetual preferred.

Common equity is known as going-concern capital. It absorbs losses when the bank has positive equity (i.e., is a going concern). Tier 2 capital is known as gone-concern capital. When the bank has negative capital and is no longer a going concern, Tier 2 capital absorbs losses. Depositors are ranked above Tier 2 capital in liquidation so theoretically, as long as Tier 2 capital is positive, depositors should be paid in full.

Capital requirements for each tier and for total capital are:

- Tier 1 equity capital must be 4.5% of risk-weighted assets at all times.
- Total Tier 1 capital (i.e., equity capital plus additional Tier 1 capital such as perpetual preferred stock) must be 6% of risk-weighted assets at all times.
- Total capital (Total Tier 1 capital plus Tier 2 capital) must be at least 8% of risk-weighted assets at all times.

By comparison, under Basel I the equity capital requirement was 2% of risk-weighted assets and the total Tier 1 capital requirement was 4% of risk-weighted assets. The new requirements are significantly more rigorous both because the percentages are higher and because the definition of what qualifies as equity capital has been tightened. The 8%

total capital requirement is the same as under Basel I and Basel II, but again, the stricter definition of equity capital applies under Basel III.

The timeline for implementation for new capital requirements is shown in Figure 2.

Figure 2: Implementation Dates for New Capital Requirements

Regulatory Change	*1/1/13*	*1/1/14*	*1/1/15*	*1/1/18*
Tier 1 Equity Capital	3.5%	4.0%	4.5%	4.5%
Tier 1 Total Capital	4.5%	5.5%	6.0%	6.0%
New Capital Definitions	Phased in	Phased in	Phased in	New definitions fully in place

Capital Conservation Buffer and Countercyclical Buffer

LO 59.5: Describe the motivations for and calculate the capital conservation buffer and the countercyclical buffer introduced in Basel III.

The **capital conservation buffer** is meant to protect banks in times of financial distress. Banks are required to build up a buffer of Tier 1 equity capital equal to 2.5% of risk-weighted assets in normal times, which will then be used to cover losses in stress periods. This means that in normal times a bank should have a minimum 7% Tier 1 equity capital ratio (i.e., 4.5% + 2.5% = 7.0%). Total Tier 1 capital must be 8.5% of risk-weighted assets and Tier 1 plus Tier 2 capital must be 10.5% of risk-weighted assets in normal periods. Banks need an extra cushion against loss during stress periods. The idea behind the buffer is that it is easier for banks to raise equity capital in normal periods than in periods of financial stress. The buffer will be phased in between January 1, 2016, and January 1, 2019.

Dividend payments are constrained when the buffer is wholly or partially used up. For example, if a bank's Tier 1 equity capital ratio is 6%, the bank must retain a minimum of 60% earnings, thus dividends cannot exceed 40% of earnings. See Figure 3 for the restrictions on dividend payments as they relate to the capital conservation buffer.

Figure 3: Dividend Restrictions Resulting from the Capital Conservation Buffer

Tier 1 Equity Capital Ratio	*Minimum Percentage of Retained Earnings*
4.000% to 5.125%	100%
5.125% to 5.750%	80%
5.75% to 6.375%	60%
6.375% to 7.000%	40%
> 7.0%	0%

Professor's Note: While the buffer requires the ratios to be 7% (Tier 1 equity), 8.5% (Total Tier 1 capital), and 10.5% (total capital) of risk-weighted assets, the ratios are expected to decline in times of market stress due to losses. At that point, the ratio requirements described in LO 59.4 are in force (i.e., 4.5%, 6.0%, and 8.0%, respectively). However, once financial markets stabilize, banks will face pressure to increase the ratios again. Given the higher equity requirements under Basel III, it will likely be difficult for banks to achieve the high returns on equity (ROE) that they enjoyed in the 15 years leading up to the financial crisis (i.e., 1990 – 2006).

While left to the discretion of individual country supervisors, Basel III also recommends that banks have a capital buffer to protect against the cyclicality of bank earnings, called the **countercyclical buffer**. The countercyclical buffer can range from 0% to 2.5% of risk-weighted assets. Like the capital conservation buffer, it must be met with Tier 1 equity capital. The buffer will be phased in between January 1, 2016, and January 1, 2019.

For countries that require the countercyclical buffer, dividend restrictions may apply. See Figure 4 for the restrictions on dividend payments as they relate to the countercyclical buffer (when set to the maximum 2.5% of risk-weighted assets), keeping in mind that the ratios are higher because the capital conservation buffer is also included. In other words, Figure 4 is a revised Figure 3, taking the additional buffer into account.

Figure 4: Dividend Restrictions Resulting from the Capital Conservation Buffer and a 2.5% Countercyclical Buffer

Tier 1 Equity Capital Ratio	*Minimum Percentage of Retained Earnings*
4.50% to 5.75%	100%
5.75% to 7.00%	80%
7.00% to 8.25%	60%
8.25% to 9.50%	40%
> 9.5%	0%

Liquidity Risk Management

LO 59.6: Describe and calculate ratios intended to improve the management of liquidity risk, including the required leverage ratio, the liquidity coverage ratio, and the net stable funding ratio.

In the wake of the 2007–2009 financial crisis, one of the primary goals of Basel III is to improve liquidity risk management in financial institutions. Basel III specifies a minimum **leverage ratio** (capital / total exposure) of 3%. As of the 2010 Basel III publication date, the type of capital required to calculate the ratio was not decided. Total exposure includes all items on the balance sheet, in their entirety (i.e., not risk-weighted). It also includes some off-balance sheet items such as loan commitments.

Banks often finance long-term obligations with short-term funds such as commercial paper or repurchase agreements. This is fine during normal economic periods. However,

in times of financial stress, this mismatched financing gives rise to liquidity risk. Banks find it difficult to roll over the short-term financing when they have, or are perceived to have, financial problems. During the 2007–2009 financial crisis, liquidity risk, not a lack of capital, was the real problem for many banks (e.g., Lehman Brothers). Basel III requires banks to meet the following two liquidity ratios: (1) liquidity coverage ratio and (2) net stable funding ratio.

Liquidity Coverage Ratio (LCR): The LCR focuses on the bank's ability to weather a 30-day period of reduced/disrupted liquidity. The severe stress considered could be a three-notch downgrade (e.g., AA to A), a loss of deposits, a complete loss of wholesale funding, a devaluation of the value of collateral for funding agreements like repurchase agreements (i.e., increased "haircuts"), and potential drawdowns on lines of credit. The ratio is computed as:

high quality liquid assets / net cash outflows in a 30-day period $\geq$ 100%

Liquid assets need to be at least as great as potential net cash outflows such that the bank can withstand one or more of the pressures described earlier.

Net Stable Funding Ratio (NSFR): The NSFR focuses on the bank's ability to manage liquidity over a period of one year. The ratio is computed as:

amount of available stable funding / amount of required stable funding $\geq$ 100%

To calculate the numerator, each source of funding (such as retail deposits, repurchase agreements, capital, and so on) is multiplied by a factor that reflects the relative stability of the funding source. See Figure 5 for the **available stable funding** (ASF) factors and types of funding available.

Figure 5: ASF Factors in NSFR

ASF Factor	*Category*
100%	Tier 1 and Tier 2 capital, preferred stock, debt with remaining maturity greater than one year.
90%	"Stable" demand and term deposits from individuals and small businesses with maturities less than one year.
80%	"Less stable" demand and term deposits from individuals and small businesses with maturities less than one year.
50%	Wholesale funding (demand and term deposits) from nonfinancial corporations, sovereigns, central banks, multi-lateral development banks, and public sector entities with maturities less than one year.
0%	All other liability and equity categories.

To calculate the denominator, each required amount of stable funding is multiplied by a factor that reflects the relative permanence of the funding required. See Figure 6 for the **required stable funding** (RSF) factors and the types of assets requiring the funding.

Figure 6: RSF Factors in NSFR

RSF Factor	*Category*
0%	Cash and short-term instruments, securities, and loans to financial entities with residual maturities of less than one year.
5%	Marketable securities with maturities of greater than one year, if claim is on a sovereign with 0% risk weight (e.g., U.S. Treasury securities).
20%	Corporate bonds with rating of AA– or higher and residual maturity greater than one year. Claims on sovereigns or similar bodies with risk-weight of 20%.
50%	Gold, equities, bonds rated A+ to A–.
65%	Residential mortgages.
85%	Loans to small businesses or retail customers with remaining maturities less than one year.
100%	All other assets.

Example: Calculating the NSFR

Bank of the Bluegrass has the following balance sheet:

Cash (coins and banknotes)	10	Retail deposits (less stable)	100
Central bank reserves	10	Wholesale deposits	75
Treasury bonds (> 1 yr)	10	Tier 2 capital	2
Mortgages	30	Tier 1 capital	18
Retail loans (< 1 yr)	30		
Small business loans (< 1 yr)	90		
Fixed assets	15		
Total assets	195	Total liabilities and equity	195

Using the information in Figures 5 and 6 to find the corresponding ASF and RSF factors, **calculate** the bank's net stable funding ratio.

Answer:

$$ASF = (100 \times 0.8) + (75 \times 0.5) + (2 \times 1.0) + (18 \times 1.0) = \$137.50$$

$$RSF = (10 \times 0) + (10 \times 0) + (10 \times 0.05) + (30 \times 0.65) + (30 \times 0.85) + (90 \times 0.85) + (15 \times 1.0) = \$137.00$$

$$NSFR = 137.50 / 137.00 = 1.0036 = 100.36\%$$

With an NSFR greater than 100%, Bank of the Bluegrass satisfies the new liquidity requirement.

These new rules represent a significant change for banks and will impact bank balance sheets. The LCR is scheduled to be implemented January 1, 2015, and the NSFR is scheduled to be implemented January 1, 2018.

Contingent Convertible Bonds

LO 59.7: Describe the mechanics of contingent convertible bonds (CoCos) and explain the motivations for banks to issue them.

Contingent convertible bonds (CoCos), unlike traditional convertible bonds, convert to equity automatically when certain conditions are met. These bonds typically convert to equity when the company or bank is experiencing financial strains. The motivation for banks to issue CoCos is that during normal financial periods, the bonds are debt and thus do not drag down return on equity (ROE). However, in periods of financial stress, the bonds convert to equity, providing a cushion against loss, which helps prevent insolvency. The needed capital is provided by private sector bondholders rather than the government, allowing the bank to avoid a bailout.

Potential triggers that activate conversion are:

- The ratio of Tier 1 equity capital to risk-weighted assets. For example, Credit Suisse issued CoCos in 2011. Conversion is triggered if Tier 1 equity capital to risk-weighted assets falls below 7%.
- Supervisors' judgment about the issuing bank's solvency prospects. For example, the Credit Suisse CoCos automatically convert if bank supervisors determine that the bank needs public sector aid (i.e., equity capital) to avoid insolvency.
- A minimum ratio of a bank's market capitalization to its assets. Market value triggers may reduce balance sheet manipulations (as one might see if the ratio of capital to risk-weighted assets is used as a trigger) but might instead introduce stock price manipulation.

Because of the increased pressure on banks to maintain higher capital levels under Basel III, it is estimated that more than $1 trillion of CoCos will be issued between 2010 and 2020.

Dodd-Frank Wall Street Reform

LO 59.8: Explain the major changes to the US financial market regulations as a result of Dodd-Frank.

The Dodd-Frank Wall Street Reform and Consumer Protection Act (Dodd-Frank) was signed into law in July 2010. The act is intended to protect consumers from abuses and prevent future bailouts and/or collapses of banks and other financial firms. Dodd-Frank has several provisions aimed at regulating banks. Some of the major changes include:

- The establishment of the **Financial Stability Oversight Council** (FSOC). The job of the FSOC is to look out for risks that affect the entire financial system. The body monitors systemic risks.
- The establishment of the **Office of Financial Research** (OFR). The OFR conducts research on the state of the economy and it, along with the FSOC, identifies risks to the financial stability of the United States. The bodies seek to maintain investor confidence and promote market discipline.
- The FSOC and the OFR are charged with identifying **systemically important financial institutions** (SIFIs). SIFIs must establish living wills that map out how the firm can be safely wound down in the event of failure. Banks that are considered too-big-to-fail must be identified and could be broken up under Dodd-Frank if their living wills are judged unacceptable. The FSOC can impose extra capital requirements on SIFIs. In the United States, a bank with more than $50 billion in assets qualifies as a SIFI. The definition is less clear for non-banks.
- The elimination of the Office of Thrift Supervision, a former supervisory body that regulated savings and loan institutions.
- The expansion of the Federal Deposit Insurance Corporation's (FDIC's) powers to liquidate banks. For example, the FDIC is allowed to take over large firms that are failing and sell their assets, even at a loss to shareholders and creditors. The financial industry, not taxpayers, should bear the costs of failures.
- Permanently increasing the FDIC deposit insurance limit from $100,000 to $250,000.
- Greater reporting requirements for large hedge funds and similar firms. These firms must now register with the SEC.
- The establishment of **Federal Insurance Office** that will work with state insurance regulators and monitor the insurance industry.
- The establishment of the **Volcker Rule**, intended to curtail proprietary trading by institutions (like banks) that accept insured deposits as a source of funding. One of the problems with this rule is that it can be difficult to distinguish between a bank's speculative trading and hedging activities.
- The requirement that some financial firms spin off high-risk trading operations into separately capitalized subsidiaries.

- Increased regulation and improved transparency of over-the-counter (OTC) derivatives including requiring standardized OTC derivatives be cleared by exchanges or by central clearing parties (CCPs). To facilitate OTC trading, swap execution facilities (SEFs) were mandated. The Commodity Futures Trading Commission (CFTC) was given responsibility to monitor CCPs and SEFs. A trade repository of all derivatives transactions will be established, improving transparency. A new Legal Entity Identifier (LEI) system will be created to assist with this goal. An LEI is a reference code that identifies a legally distinct entity engaging in a financial transaction.
- The Federal Reserve must set risk management standards for systemically important financial institutions engaged in clearing, settlement, and payment functions.
- The requirement that rating agencies be more transparent in their assumptions and methods used to rate firms. An **Office of Credit Ratings** was created to monitor rating agencies. The potential legal liabilities of rating agencies were also increased under Dodd-Frank.
- The use of external credit ratings in the regulation of banks and other financial institutions was banned. This is in direct conflict with the Basel Committee, which uses external credit ratings to set some capital requirements.
- Individual protections were increased, both for investors and consumers. The **Bureau of Financial Protection** was created within the Federal Reserve to ensure that consumers understand loan applications and terms for things like mortgages and credit cards. The goal is that consumers receive clear and accurate information when they shop for financial products and services.
- Firms are required, with some exceptions, to keep a minimum of 5% of the assets they securitize.
- Changes in compensation. Compensation packages that encourage short-term performance goals that may lead to increased risk taking are discouraged. Shareholders were given a non-binding vote on executive compensation packages. Board compensation committees must be made up of independent directors.
- Banks are required to assess a mortgage borrower's ability to repay. Foreclosures may be disallowed if a bank does not make a good faith effort to determine that the borrower can repay the loan.
- At least one board member should have risk management experience at large, complex organizations.

Key Concepts

LO 59.1

Basel II.5 requires banks to calculate two market risk VaRs. The first is the usual VaR required in Basel II, using the historical simulation method. The second is a stressed VaR, using a 250-day period of stressed market conditions. To calculate the stressed VaR, banks must identify a one-year period when their portfolios performed poorly. The total market risk capital charge is the sum of the usual bank VaR and the stressed VaR.

LO 59.2

The Basel Committee proposed an incremental default risk charge (IDRC) in 2005 to correct for the fact that the banking book was attracting more capital than the trading book in most banks. For instruments in the trading book that are sensitive to default risk, the IDRC requires the bank to calculate a 99.9% confidence level, one-year time horizon VaR. This was altered to account for ratings change sensitivities in addition to default sensitivities following the 2007–2009 financial crisis and became known as the incremental risk charge (IRC). Banks must estimate a liquidity horizon for each instrument and rebalance the portfolio if credit quality declines.

LO 59.3

The comprehensive risk measure (CRM) accounts for risks in the correlation book. Asset-backed securities (ABS) and collateralized debt obligations (CDOs) are sensitive to the default risk of other assets. For example, they are sensitive to the default risk of the securitized assets that collateralize the instruments. The committee has specified a standardized approach to assign capital charges for rated instruments. Resecuritizations, such as CDOs of ABSs, have higher risk weights than normal securitizations, such as mortgage-backed securities. For unrated instruments or instruments rated below BB–, the bank must deduct the principal amount of the exposure from capital which is equivalent to a 100% capital charge.

LO 59.4

Basel III increased capital requirements for credit risk and tightened the definition of what qualifies as Tier 1 and Tier 2 capital. Basel III eliminated Tier 3 capital. Under Basel III, a bank's total capital consists of Tier 1 equity capital (primarily common stock plus retained earnings), additional Tier 1 capital (primarily non-cumulative perpetual preferred), and Tier 2 capital (primarily debt subordinated to depositors with an original maturity of at least five years). By January 1, 2015, Tier 1 equity capital must be at least 4.5% of risk-weighted assets, total Tier 1 capital must be 6% of risk-weighted assets, and total capital (Tier 1 plus Tier 2) must be at least 8% of risk-weighted assets.

LO 59.5

The capital conservation buffer protects banks in times of financial distress. Banks are required to build up a buffer of Tier 1 equity capital equal to 2.5% of risk-weighted assets in normal times, which will then be used to cover losses in stress periods. This means that in normal times a bank should have a minimum 7% Tier 1equity capital ratio. Total Tier 1 capital must be 8.5% of risk-weighted assets and Tier 1 plus Tier 2 capital must be 10.5% of risk-weighted assets in normal periods. Dividend restrictions apply when capital ratios fall below required levels.

Basel III also recommends that banks have a capital buffer to protect against the cyclicality of bank earnings, called the countercyclical buffer. This requirement is left to the discretion of individual country supervisors and can range from 0% to 2.5% of risk-weighted assets.

LO 59.6

One of the primary goals of Basel III is to improve liquidity risk management in financial institutions. Basel III requires banks to meet the following three liquidity ratios:

1. A minimum leverage ratio (capital / total exposure) of 3%. Total exposure includes all items on the balance sheet in their entirety (i.e., not risk-weighted) and some off-balance sheet items, such as loan commitments.

2. A minimum liquidity coverage ratio (high quality liquid assets / net cash outflows in a 30-day period) of 100%. The LCR focuses on the bank's ability to weather a 30-day period of reduced/disrupted liquidity.

3. A minimum net stable funding ratio (amount of stable funding / required amount of stable funding) of 100%. The NSFR focuses on the bank's ability to manage liquidity over a period of one year.

LO 59.7

Contingent convertible bonds (CoCos) convert to equity automatically when certain conditions are met, usually when the company or bank is experiencing financial stresses. The motivation for banks to issue CoCos is that during normal financial periods, the bonds are debt and thus do not weigh down return on equity (ROE). However, in periods of financial stress, the bonds convert to equity, providing a cushion against loss and preventing insolvency and potentially allowing the bank to avoid a bailout.

LO 59.8

Dodd-Frank was signed into law in July 2010. The act is intended to protect consumers from abuses and prevent future bailouts and/or collapses of banks and other financial firms. Dodd-Frank has many provisions aimed at regulating banks. Some of the more important provisions are as follows:

- The establishment of the Financial Stability Oversight Council (FSOC). The job of the FSOC is to look out for risks that affect the entire financial system.
- The establishment of the Office of Financial Research (OFR). The OFR conducts research on the state of the economy and it, along with the FSOC, identifies risks to the financial stability of the United States.
- The FSOC and the OFR are charged with identifying systemically important financial institutions (SIFIs). SIFIs must establish living wills that map out how the firm can be safely wound down in the event of failure. Banks that are considered too-big-to-fail must be identified and could be broken up under Dodd-Frank if their living wills are judged unacceptable. SIFIs may also be required to hold additional capital.
- Permanently increasing the FDIC deposit insurance limit from $100,000 to $250,000.
- The establishment of the Volcker Rule, intended to curtail proprietary trading by banks.
- The Bureau of Financial Protection was created within the Federal Reserve to ensure that consumers understand loan applications and terms for things like mortgages and credit cards. The goal is that consumers receive clear and accurate information when they shop for financial products and services.
- Increased regulation and improved transparency for over-the-counter (OTC) derivatives including requiring standardized OTC derivatives be cleared by exchanges or by central clearing parties (CCPs).

Concept Checkers

1. Which of the following statements about a stressed VaR, required under Basel II.5, is correct?
   A. Basel II.5 has established the year 2008 as the "stress" period. All banks use data from 2008 to calculate the stressed VaR.
   B. The stressed VaR replaces the "normal" VaR for the purpose of calculating capital for credit risks.
   C. Market risk capital under Basel II.5 should be at least double that of market risk capital under Basel II due to the addition of the stressed VaR.
   D. The stressed VaR must be calculated using a 99.9% confidence interval.

2. Banks are required to rebalance their portfolios as the creditworthiness of bonds decline, leading to losses over time but generally not to outright default. This requirement to specify a liquidity horizon for each instrument in the portfolio and rebalance at the end of the liquidity horizon is part of the:
   A. incremental risk charge calculation.
   B. net stable funding charge formula.
   C. countercyclical buffer estimation.
   D. comprehensive risk measure calculation.

3. Which form of capital must be adjusted downward to reflect deficits in defined benefit pension plans under Basel III?
   A. Tier 1 capital.
   B. Tier 2 capital.
   C. Tier 3 capital.
   D. There is no requirement under Basel III to adjust capital downward to reflect deficits in defined benefit pension plans.

4. The capital conservation buffer:
   A. is intended to protect banks from the countercyclical nature of bank earnings.
   B. can be set between 0.0% and 2.5% of risk-weighted assets, and is at the discretion of the regulators in individual countries.
   C. causes the Tier 1 equity capital ratio requirement to increase to 7% of risk-weighted assets in normal economic periods.
   D. requires that total capital to risk-weighted assets must be 10.5% at all times.

5. Highlands Bank has estimated stable funding in the bank to be $100 million. The bank estimates that net cash outflows over the coming 30 days will be $137 million. The bank has capital of $5 million and a total exposure of $140 million. The bank estimates that it has high-quality liquid assets of $125 million. What is the bank's liquidity coverage ratio (LCR)?
   A. 89.3%.
   B. 91.2%.
   C. 73.0%.
   D. 3.6%.

Concept Checker Answers

1. **C** Basel II.5 required banks to calculate two VaRs, the usual VaR, using the historical simulation method, and a stressed VaR, using a 99% confidence level, 250-day period of stressed market conditions. The total market risk capital charge is the sum of the usual bank VaR and the stressed VaR. Initially, regulators thought the year 2008 would be ideal for stressed market conditions. However, banks are now required to identify a one-year period when their portfolios performed poorly. This means the stressed period may be different across banks.

2. **A** As part of the incremental risk charge (IRC) calculation, banks are required to estimate a liquidity horizon for each instrument in the portfolio. For example, assume an AA+-rated bond in the portfolio has a liquidity horizon of three months. If, at the end of three months, the bond has defaulted or has been downgraded, it is assumed that the bank will replace the bond with an AA+-rated bond comparable to the one held at the start of the period. This rebalancing is assumed at the end of each three-month period (or six months, nine months, etc., depending on the estimated liquidity horizon). Rebalancing allows banks to take losses as instruments are downgraded but generally allows the bank to avoid defaults.

3. **A** Tier 1 includes common equity including retained earnings (called Tier 1 equity capital or Tier 1 common capital) and non-cumulative perpetual preferred stock (additional Tier 1 capital, part of total Tier 1capital). Tier 1 capital does not include goodwill, deferred tax assets, changes in retained earnings arising from securitized transactions, or changes in retained earnings arising from the bank's credit risk. Tier 1 capital is adjusted downward to reflect defined benefit pension plan deficits (but is not adjusted upward for surpluses). Tier 2 or supplementary capital includes debt subordinated to depositors with an original maturity of five years or more. Tier 3 capital was eliminated under Basel III.

4. **C** The capital conservation buffer is meant to protect banks in times of financial distress. Banks are required to build up a buffer of Tier 1 equity capital equal to 2.5% of risk-weighted assets in normal times, which will then be used to cover losses in stress periods. This means that in normal times, a bank should have a minimum 7% Tier 1equity capital to risk-weighted assets ratio, an 8.5% total Tier 1 capital to risk-weighted assets ratio, and a 10.5% Tier 1 plus Tier 2 capital to risk-weighted assets ratio. The capital conservation buffer is a requirement and is not left to the discretion of individual country regulators. It is not a requirement at all times but is built up to that level in normal economic periods and declines in stress periods.

5. **B** Basel III requires a minimum liquidity coverage ratio of 100%. The LCR focuses on the bank's ability to weather a 30-day period of reduced/disrupted liquidity. The formula is computed as follows:

   high-quality liquid assets / net cash outflows in a 30-day period

   LCR = \$125 million / \$137 million = 0.912 or 91.2%.

   In this case, Highlands Bank does not meet the minimum 100% requirement and is in violation of the rule.

The following is a review of the Operational and Integrated Risk Management principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

Fundamental Review of the Trading Book

Topic 60

Exam Focus

The new banking capital requirements, as specified in this topic, will profoundly change the way that capital for market risk is calculated. There are several key innovations that will cause this change. First, banks will be required to forgo using the 99% confidence interval VaR measure in favor of the 97.5% confidence interval expected shortfall measure. This change will better capture the potential dollar loss (i.e., tail risk) that a bank could sustain in a given window of time. Many risk managers have already begun using expected shortfall in practice for internal audits. Second, risk assets will be divided into liquidity horizons that better reflect the volatility in specific asset categories. The third innovation is a rules-based criteria for an asset being categorized as either a trading book asset or a banking book asset. This step will help mitigate the potential for regulatory arbitrage.

Market Risk Capital Calculation

LO 60.1: Describe the proposed changes to the Basel market risk capital calculation and the motivations for these changes, and calculate the market risk capital under this method.

In May 2012, the Basel Committee on Banking Supervision began considering the next round of changes to market risk capital calculations for banks. This process is known as the **Fundamental Review of the Trading Book** (FRTB). After receiving comments on proposals and seeing the results of a formal study, the rules were further refined in December 2014. It is important for risk managers to understand the nature of the proposed changes and the new calculation methodology.

In order to properly understand the changes, it is necessary to first understand the previous market risk requirements. The Basel I calculations for market risk capital involved a 10-day **value at risk** (VaR) calculated with a 99% confidence interval. This process produced a very current result because the 10-day horizon incorporated a recent period of time, which typically ranged from one to four years. The Basel II.5 calculations required banks to add a stressed VaR measure to the current value captured with the 10-day VaR. The stressed VaR measures the behavior of market variables during a 250-day period of stressed market conditions. Banks were required to self-select a 250-day window of time that would have presented unusual difficulty for their current portfolio.

The FRTB researched if the 10-day VaR was really the best measurement for a bank's true risk. The value at risk measure has been criticized for only asking the question: "How bad can things get?" VaR communicates, with a given level of confidence, that the bank's

losses will not exceed a certain threshold. Consider a bank that uses a 10-day VaR with a 99% confidence interval and finds that losses will only exceed $25 million in 1% of all circumstances. What if the 1% chance involves a $700 million loss? This could be a catastrophic loss for the bank. Therefore, the FRTB has proposed an alternate measure using **expected shortfall** (ES), which is a measure of the impact on the profit and loss statement (P&L) for any given shock of varying lengths. The expected shortfall asks the question: "If things get bad, what is the estimated loss on the bank's P&L?"

Consider the following example that illustrates the difference between value at risk and expected shortfall. A bank has a $950 million bond portfolio with a 2% probability of default. The default schedule appears in Figure 1.

Figure 1: Example Default Schedule for $950 Million Bond Portfolio

Confidence Level	*Default*	*Loss*
95%	No	$0
96%	No	$0
97%	No	$0
98%	No	$0
99%	**Yes**	**$950 million**
99.9%	**Yes**	**$950 million**

At the 95% confidence interval, there is still no expected loss, so the 95% VaR would imply a $0 of loss. However, the expected shortfall measure accounts for the potential dollar loss conditional on the loss exceeding the 95% VaR level. In this case, three out of five times the expected loss is still $0, but two out of five times the expectation is for a total loss of the $950 million bond portfolio's value due to default. This means that 40% of the tail risk would yield a loss, so the expected shortfall is $380 million (i.e., 40% × $950 million). This presents a very different risk perspective than using the VaR measure alone.

Instead of using a 10-day VaR with a 99% confidence interval, the FRTB is proposing the use of expected shortfall with a 97.5% confidence interval. For a normal distribution, with mean of μ and standard deviation of σ, these two measures yield approximately the same result. The 99% VaR formula is $\mu + 2.326\sigma$, and the 97.5% expected shortfall formula is $\mu + 2.338\sigma$. However, if distributions have fatter tails than a normal distribution, then the 97.5% expected shortfall can be considerably different from the 99% VaR.

Under this FRTB proposal, banks would be required to forgo combining a 10-day, 99% VaR with a 250-day stressed VaR, and instead calculate capital based on expected shortfall using a 250-day stressed period exclusively. Just as with the 250-day stressed VaR, banks would be charged with self-selecting a 250-day window of time that would be exceptionally difficult financially for the bank's portfolio.

Professor's Note: There are approximately 250 trading days in a 12-month time period. This is why 250-day time windows are used. Following the same logic, a 120-day window equates to six months, a 60-day window equates to one quarter (three months), a 20-day window equates to one month, and a 10-day window is essentially two weeks.

Liquidity Horizons

LO 60.2: Compare the various liquidity horizons proposed by the Fundamental Review of the Trading Book (FRTB) for different asset classes and explain how a bank can calculate its expected shortfall using the various horizons.

According to the Basel Committee, a **liquidity horizon** (LH) is "the time required to execute transactions that extinguish an exposure to a risk factor, without moving the price of the hedging instruments, in stressed market conditions." The standard 10-day LH was not deemed appropriate given the actual variations in liquidity of the underlying transactions. Five different liquidity horizons are now in use: 10 days, 20 days, 60 days, 120 days, and 250 days. Consider the 60-day horizon, which is essentially three months worth of trading days. The calculation of regulatory capital for a 60-day horizon is intended to shelter a bank from significant risks while waiting three months to recover from underlying price volatility.

Under FRTB proposals, every risk factor is assigned a liquidity horizon for capital calculations. For example, investment grade sovereign credit spreads are assigned a 20-day horizon, while non-investment grade corporate credit spreads are assigned a 120-day horizon and structured products have a 250-day horizon. See Figure 2 for a sample listing of liquidity horizons.

Figure 2: Allocation of Risk Factors to Liquidity Horizons

Risk Factors	*Horizon (in Days)*
Interest rate (EUR, USD, GBP, AUD, JPY, SEK, and CAD)	10
Interest rate (other)	20
Interest rate at-the-money (ATM) volatility	60
Credit spread: sovereign, investment grade	20
Credit spread: sovereign, non-investment grade	60
Credit spread: corporate, investment grade	60
Credit spread: corporate, non-investment grade	120
Credit spread: structured products	250
Equity price: large cap	10
Equity price: small cap	20
Equity price: large cap ATM volatility	20
Equity price: small cap ATM volatility	120
FX rate (liquid currency pairs)	10
FX rate (other currency pairs)	20
FX volatility	60
Energy price	20
Precious metal price	20
Energy price ATM volatility	60
Precious metal ATM volatility	60

The Basel committee's original idea was to utilize overlapping time periods for stress testing. They initially wanted to find a time period's expected shortfall (ES) by scaling smaller time periods up to longer time periods using a series of trials. Consider a bank that has a 10-day risk asset, like large-cap equity, and a 120-day risk asset, like a non-investment grade corporate credit spread. In the first trial, they would measure the stressed P&L changes from Day 0 to Day 10 for the large-cap equity and also the value change from Day 0 to Day 120 for the non-investment grade corporate credit spread. The next trial would measure the change from Day 1 to Day 11 on the large-cap equity and from Day 1 to Day 121 for the credit spread. The final simulated trial would measure Day 249 to Day 259 for the large-cap equity and Day 249 to Day 369 for the credit spread. The ES used would then be the average loss in the lower 2.5% tail of the distribution of the 250 trials.

After the initial idea was submitted for comments, it was revised in December 2014 to incorporate five categories. The rationale was to reduce implementation costs. The updated categories are as follows:

- Category 1 is for risk factors with 10-day horizons.
- Category 2 is for risk factors with 20-day horizons.
- Category 3 is for risk factors with 60-day horizons.
- Category 4 is for risk factors with 120-day horizons.
- Category 5 is for risk factors with 250-day horizons.

Using this revised, categorical process attempts to account for the fact that risk factor shocks might not be correlated across liquidity horizons.

This proposed new process is formally known as the **internal models-based approach** (IMA). In the internal models-based approach, expected shortfall is measured over a base horizon of 10 days. The expected shortfall is measured through five successive shocks to the categories in a nested pairing scheme using ES_{1-5}. ES_1 is calculated as a 10-day shock with intense volatility in all variables from category 1–5. ES_2 is calculated as a 10-day shock in categories 2–5, holding category 1 constant. ES_3 is calculated as a 10-day shock in categories 3–5, holding category 1 and 2 constant. ES_4 is calculated as a 10-day shock in categories 4–5, holding categories 1–3 constant. The final trial, ES_5, is calculated as a 10-day shock in category 5, holding categories 1–4 constant. The idea is to measure the hit to the bank's P&L for ES_{1-5}. The overall ES is based on a waterfall of the categories, as described above, and is scaled to the square root of the difference in the horizon lengths of the nested risk factors. This relationship is shown in the following formula:

$$ES = \sqrt{ES_1^2 + \sum_{j=2}^{5}\left(ES_j\sqrt{\frac{LH_j - LH_{j-1}}{10}}\right)^2}$$

Until the internal models-based approach has been formally approved, banks must continue to use what is known as the **revised standardized approach**. This process groups risk assets with similar risk characteristics into "buckets," which are essentially just organized around

liquidity horizons. The standardized risk measure for each bucket is then calculated using the following formula:

$$\sum_i w_i^2 v_i^2 + 2\sum_i \sum_{j<i} \rho_{ij} w_i w_j v_i v_j$$

where:
v_i = the value of the ith risk factor
w_i = a weighting factor established by the Basel Committee
ρ_{ij} = the correlation established by the Basel Committee

In order to find the regulatory capital, the standardized risk measures are then combined for each bucket. Regulators may require that capital calculated using the new internal models-based approach be at least some set percentage of the revised standardized approach.

Proposed Modifications to Basel Regulations

LO 60.3: Explain proposed modifications to Basel regulations in the following areas:
- **Classification of positions in the trading book compared to the banking book**
- **Treatment of credit spread and jump-to-default risk, including the incremental default risk charge**

The FRTB also addressed regulatory modifications. One modification is to clarify if a risk asset should be considered part of the trading book or the banking book. Historically, the trading book consisted of risk assets that the bank intended to trade. **Trading book** assets have been periodically marked-to-market. The banking book has consisted of assets that are intended to be held until maturity, and they are held on the books at cost. **Banking book** assets are subject to more stringent credit risk capital rules, while trading book assets are subject to market risk capital rules. Using different rules has enabled a form of regulatory arbitrage where banks will hold credit-dependent assets in the trading book to relax capital requirements.

In an attempt to mitigate this regulatory arbitrage, the FRTB makes a specific distinction between assets held in the trading book and those held in the banking book. To be allocated to the trading book, the bank must prove more than an intent to trade. They must meet dual criteria of: (1) being able to trade the asset, and (2) physically managing the associated risks of the underlying asset on the trading desk. If these two criteria are met, then an asset can be allocated to the trading book, but the day-to-day price fluctuations must also affect the bank's equity position and pose a risk to bank solvency.

Another important distinction was made in terms of reclassification between a banking book asset and a trading book asset. Once an asset has been acquired and initially assigned to either the trading book or the banking book, it cannot be reclassified except for extraordinary circumstances. This roadblock has been established to minimize the act of switching between categories at will, based on how capital requirements are calculated.

An example of an extraordinary circumstance is if the bank changes accounting practices that is a firm-wide shift. Another caveat is that any benefit derived from calculating capital requirements under a post-shift category is disallowed. The capital requirement of the original method must be retained.

Basel II.5 also introduced the **incremental risk charge** (IRC) to further mitigate this regulatory arbitrage. The IRC recognizes two different types of risk created by credit-dependent risk assets: (1) credit spread risk, and (2) jump-to-default risk.

Credit spread risk is the risk that a credit risk asset's credit spread might change and thus cause the mark-to-market value of the asset to change. This risk can be addressed by using the expected shortfall calculation process discussed earlier. The IRC process allows banks to assume a constant level of risk. This means that it is assumed that positions that deteriorate are replaced with other risk assets. For example, if a bank has an A-rated bond with a three-month liquidity horizon that suffers a credit-related loss, then it is assumed that the bank replaces this risk asset with another A-rated bond at the end of the three-month liquidity horizon. This is clearly a simplifying assumption, which is being replaced with incremental marking-to-market without assuming replacement under the FRTB proposals.

Jump-to-default risk is the risk that there will be a default by the issuing company of the risk asset. A default would lead to an immediate and potentially significant loss for the bank that holds the defaulted issuer's risk asset. This risk is subject to an **incremental default risk** (IDR) charge. The IDR calculation applies to all risk assets (including equities) that are subject to default. It is calculated based on a 99.9% VaR with a one-year time horizon.

Key Concepts

LO 60.1

The Fundamental Review of the Trading Book (FRTB) is changing the historical reliance on 10-day value at risk (VaR) with a 99% confidence interval combined with a 250-day stressed VaR. The new calculation will require the use of expected shortfall with a 97.5% confidence interval. This switch will better capture the value of capital at risk below a certain confidence interval.

LO 60.2

The FRTB is establishing various liquidity horizons, which are the length of time "required to execute transactions that extinguish an exposure to a risk factor, without moving the price of the hedging instruments, in stressed market conditions." The expected shortfall will then be calculated by structuring risk assets into categories and solving for an overall value of expected shortfall for a bank's risk assets.

LO 60.3

Some banks have engaged in regulatory arbitrage by actively switching assets between the trading book and the banking book depending on which category would show their capital requirements in a more favorable light. The FRTB is mitigating this arbitrage opportunity by deploying a rules-based standard for classification into these categories and a roadblock for easily switching between them.

Concept Checkers

1. Which of the following statements regarding the differences between Basel I, Basel II.5, and the Fundamental Review of the Trading Book (FRTB) for market risk capital calculations is incorrect?
   A. Both Basel I and Basel II.5 require calculation of VaR with a 99% confidence interval.
   B. FRTB requires the calculation of expected shortfall with a 97.5% confidence interval.
   C. FRTB requires adding a stressed VaR measure to complement the expected shortfall calculation.
   D. The 10-day time horizon for market risk capital proposed under Basel I incorporates a recent period of time, which typically ranges from one to four years.

2. What is the difference between using a 95% value at risk (VaR) and a 95% expected shortfall (ES) for a bond portfolio with $825 million in assets and a probability of default of 3%?
   A. Both measures will show the same result.
   B. The VaR shows a loss of $495 million while the expected shortfall shows no loss.
   C. The VaR shows no loss while the expected shortfall shows a $495 million loss.
   D. The VaR shows no loss while the expected shortfall shows a $395 million loss.

3. Which of the following statements best describe how the internal models-based approach (IMA) incorporates various liquidity horizons into the expected shortfall calculation?
   A. A rolling 10-day approach is used over a 250-day window of time.
   B. Smaller time periods are used to extrapolate into larger time periods.
   C. A series of weights are applied to the various liquidity horizons along with a correlation factor determined by the Basel Committee.
   D. The expected shortfall is based on a waterfall of the liquidity horizon categories and is then scaled to the square root of the difference in the horizon lengths of the nested risk factors.

4. Which of the following statements represents a criteria for classifying an asset into the trading book?
   I. The bank must be able to physically trade the asset.
   II. The risk of the asset must be managed by the bank's trading desk.

   A. I only.
   B. II only.
   C. Both I and II.
   D. Neither I nor II.

5. Which of the following risks is specifically recognized by the incremental risk charge (IRC)?
   A. Expected shortfall risk, because it is important to understand the amount of loss potential in the tail.
   B. Jump-to-default risk, as measured by 99% VaR, because a default could cause a significant loss for the bank.
   C. Equity price risk, because a change in market prices could materially impact mark-to-market accounting for risk.
   D. Interest rate risk, as measured by 97.5% expected shortfall, because an increase in interest rates could cause a significant loss for the bank.

Concept Checker Answers

1. **C** Basel I and Basel II.5 use VaR with a 99% confidence interval and the FRTB uses the expected shortfall with a 97.5% confidence interval. Basel I market risk capital requirements produced a very current result because the 10-day horizon incorporated a recent period of time. The FRTB does not require adding a stressed VaR to the expected shortfall calculation. It was Basel II.5 that required the addition of a stressed VaR.

2. **C** The VaR measure would show a $0 loss because the probability of default is less than 5%. Having a 3% probability means that three out of five times, in the tail, the portfolio will experience a total loss. The potential loss is $495 million (= 3/5 × $825 million).

3. **D** The expected shortfall is based on a waterfall of the liquidity horizon categories and is then scaled to the square root of the difference in the horizon lengths of the nested risk factors.

4. **C** The criteria for classification as a trading book asset are: (1) the bank must be able to physically trade the asset, and (2) the bank must manage the associated risks on the trading desk.

5. **B** The two types of risk recognized by the incremental risk charge are: (1) credit spread risk, and (2) jump-to-default risk. Jump-to-default risk is measured by 99% VaR and not 97.5% expected shortfall.

The following is a review of the Operational and Integrated Risk Management principles designed to address the learning objectives set forth by GARP®. This topic is also covered in:

Sound Management of Risks Related to Money Laundering and Financing of Terrorism

Topic 61

Exam Focus

This topic focuses on the Basel Committee's recommendations for identifying, assessing, and managing the risks associated with money laundering and the financing of terrorism (ML/FT) through banks. The concept of customer due diligence (CDD) is important and focuses on the precautionary steps a bank must take to ensure it knows the true identities of the customers with which it is dealing. Because many of the higher risk situations arise out of international, cross-border transactions, much of the recommendations focus on the risks associated with these activities. For the exam, understand who bears the ultimate responsibility for customer identification and verification, even if a third party is hired to carry out CDD. Also, know the responsibilities of both the correspondent and respondent banks in a correspondent banking relationship.

Best Practices

LO 61.1: Explain best practices recommended by the Basel Committee for the assessment, management, mitigation, and monitoring of money laundering and financial terrorism (ML/FT) risks.

The Basel committee (referred to as the Committee) is committed to combating **money laundering** (ML) and the **financing of terrorism** (FT) as part of its mandate to enhance worldwide financial stability via a strengthening of regulation, supervision, and bank practices. The Committee has a long-standing commitment to sound **Anti-Money Laundering and Countering Financing of Terrorism** (AML/CFT) policies and procedures in banks. Banks without sound ML/FT risk management practices are exposed to serious risks including, but not limited to: reputational, operational, compliance, and concentration risks. Costs associated with these risks include fines and sanctions by regulators, the termination of wholesale funding and facilities, claims against the bank, loan losses, asset seizures, asset freezes, and investigative costs.

Risk Assessment

The Committee's *Core Principles for Effective Banking Supervision* was updated in 2012 and requires that all banks, "have adequate policies and processes, including strict **customer due diligence** (CDD) rules to promote high ethical and professional standards in the banking sector and prevent the bank from being used, intentionally or unintentionally, for criminal activities." Sound risk management means the bank must identify and manage

ML/FT risks, designing and implementing policies and procedures corresponding to the identified risks. These risks must be assessed at the country, sector, bank, and business relationship levels. The bank must have policies and procedures for:

- Customer identification.
- Customer due diligence.
- Customer acceptance.
- Monitoring of business relationships.
- Monitoring of business operations.

The bank must develop a thorough understanding of ML/FT risks present in:

- The customer base.
- The bank's products and services.
- The delivery channels for products and services, including products and services in the development stage.
- The jurisdictions within which the bank and the bank's customers do business.

The bank's understanding of inherent ML/FT risks is based on both internal and external data sources, including operational and transaction data (internal) and national risk assessments and country reports from international organizations (external).

Risk Management

Proper governance arrangements are necessary for the management of ML/FT risks. Prior publications from the Committee (specifically, *The Internal Audit Function in Banks*, June 2012, *Principles for Enhancing Corporate Governance*, October 2010, and *Compliance and the Compliance Function in Banks*, April 2005) describe proper governance arrangements. In particular, these publications require the board of directors to approve and oversee risk policies, risk management activities, and compliance. These functions are critical to the management and mitigation of ML/FT risks. ML/FT risk assessments must be communicated to the board of directors in a timely, complete, accurate, and understandable manner.

The board of directors and senior management should appoint a qualified chief AML/CFT officer with the stature and authority to garner the attention of the board, senior management, and business lines when ML/FT issues arise.

Risk Mitigation

First line of defense. The **business units** (e.g., the front office and customer facing activities) are the first line of defense in identifying, assessing, and controlling ML/FT risks. Policies and procedures should be specified in writing and communicated to bank personnel. Employees should know what they are supposed to do and how to comply with regulations. There should be procedures in place for detecting and reporting suspicious transactions. High ethical and professional standards are essential. The bank should carry out employee training on how to identify and report suspicious transactions.

Second line of defense. The **chief officer in charge of AML/CFT** is the second line of defense. The officer should engage in ongoing monitoring and the fulfillment of AML/CFT duties. The officer should be the contact person for AML/CFT issues both internally and externally

[e.g., supervisory authorities and financial intelligence units (FIUs)]. To avoid conflicts of interest, the officer should not have business line responsibilities or be responsible for data protection or internal audits. The officer may also be the chief risk officer and should have a direct reporting line to senior management and/or the board of directors.

Third line of defense. The third line of defense is **internal audits**. The bank should establish policies for conducting internal audits of the bank's AML/CFT policies. **External audits** may also play a role in evaluating a bank's policies and procedures with respect to the AML/CFT function.

Risk Monitoring

The bank's risk monitoring systems should be commensurate with the bank's size, activities, and complexity. For most banks, and especially for banks that are internationally active, some of the monitoring activities will be automated. A bank must document its decision to forgo information technology (IT) monitoring and demonstrate an effective alternative. Monitoring systems should be able to provide accurate information to senior management on issues such as changes in the transactional profiles of bank customers. The IT system should also enable a bank to determine its own criteria for monitoring and filing **suspicious transaction reports** (STR) or taking other steps to minimize ML/FT risks. Internal audits should evaluate the effectiveness of IT monitoring systems.

LO 61.2: Describe recommended practices for the acceptance, verification, and identification of customers at a bank.

Customer Acceptance

Banks must determine which customers pose a high risk of ML/FT. Factors the bank should consider include the customer's:

- Background.
- Occupation including public and/or high profile figures.
- Business activities.
- Sources of income and wealth.
- Country of origin.
- Country of residence, if different from country of origin.
- Choice and use of bank products and services.
- Nature and purpose of the bank account.
- Linked accounts.

For lower-risk customers, simplified assessment procedures may be used (e.g., a customer with low balances who uses the account for routine banking needs). Also, the customer acceptance standards must not be so restrictive that they deny access to the general public, especially financially or socially disadvantaged persons.

Enhanced due diligence may be required for:

- Accounts with large balances and regular cross-border wire transfers.
- A politically exposed person (PEP), especially foreign PEPs.

Banks must determine the risks they are willing to accept in order to do business with higher-risk customers. The bank must also determine the circumstances under which it will not accept a new business relationship or will terminate an existing relationship.

Customer Verification

The Financial Action Task Force (FATF) Recommendation 10 defines a *customer* as any person entering into a business relationship with a bank or carrying out an occasional financial transaction with a bank. Banks must, according to FATF standards, identify customers and verify their identity. Banks must establish a systematic procedure for identifying and verifying customers. In some cases, the bank must identify and verify a person acting on behalf of a beneficial owner(s).

In terms of verification of a person's identity, the bank must be aware that the best documentation is that which is difficult to forge or to obtain illicitly. A bank may require a written declaration of the identity of a beneficial owner but should not rely solely on such a declaration. A bank must not forgo identification and verification simply because the customer cannot be present for an interview. The bank should pay particular attention to customers from jurisdictions that are known to have AML/CFT deficiencies. Enhanced due diligence is called for in these circumstances.

Customer Identification

In order to develop customer risk profiles (or categories of customers), the bank should collect data pertaining to the:

- Purpose of the relationship or of the occasional banking transaction.
- Level of assets.
- Size of the transactions of the customer.
- Regularity or duration of the banking relationship.
- Expected level of activity.
- Types of transactions.
- Sources of customer funds, income, or wealth (if necessary).

The bank should identify "normal" behavior for particular customers or categories of customers and activities that deviate from normal and might be labeled unusual or suspicious.

Customer identification documentation may include:

- Passports.
- Identity cards.
- Driving licenses.
- Account files such as financial transaction records.
- Business correspondence.

If the bank cannot perform CDD, it should not open the account or perform a transaction. If the bank must, so as to not interrupt the normal conduct of business, engage in a business transaction prior to verification, and ultimately cannot verify the customer's identity, then the bank should consider filing an STR. The customer should *not* be informed that the STR has been or will be filed, either directly or indirectly.

If the bank believes a customer has been refused banking services from another bank due to concerns about illicit activities, the bank should consider classifying the customer as high risk and engage in enhanced CDD or reject the customer altogether. If the customer insists on anonymity (or gives an obviously fictitious name), the bank should refuse to accept the customer. Numbered accounts may provide a level of confidentiality for a customer, but the bank must still verify the identity of the account holder.

Ongoing monitoring of customer accounts and vigilant record-keeping are necessary to ML/FT risk management.

LO 61.3: Explain practices for managing ML/FT risks in a group-wide and cross-border context, and describe the roles and responsibilities of supervisors in managing these risks.

ML/FT Risk Management for Cross-Border Banks

When a bank operates in multiple jurisdictions, it is subject to numerous country regulations. Each banking group [*group* refers to an organization's one or more banks and the branches and subsidiaries of the bank(s)] should develop group-wide AML/CFT policies and procedures and consistently apply those policies across the group's international operations. Policies should be consistently applied (and supportive of the group's broader policies and procedures regarding ML/FT risks) even if requirements differ across jurisdictions. If the host jurisdiction's requirements are stricter than the group's home country, the branch or subsidiary should adopt the host jurisdiction requirements.

If a host country does not permit the proper implementation of FATF standards, then the chief AML/CFT officer should inform home supervisors. In some instances, the bank may need to close operations in the host country.

In a cross-border context, AML/CFT procedures are more challenging than other risk management processes because some jurisdictions restrict a bank's ability to transmit customer names and balances across national borders. However, for risk management purposes, it is essential that banks be able to, subject to legal protections, share information about customers with head offices or the parent bank.

Risk assessment and management activities, such as customer risk assessments, group-wide risk assessments, and internal and external audits, apply to multi-national banks. When business is being referred to a bank, the bank's own AML/CFT standards must be used in place of the jurisdiction of the referring bank, unless the introducer is in a jurisdiction with equal or stricter standards and requirements.

Banks involved in cross-border activities should:

- Integrate information on the customer, beneficial owners of the customer, and the funds involved in the transaction(s).
- Monitor significant customer relationships, balances, and activity on a consolidated basis whether the account is on- or off-balance sheet, as assets under management (AUM), or on a fiduciary basis.

- Appoint a chief AML/CFT officer for the whole group who must ensure group-wide compliance (across borders) of AML/CFT requirements.
- Oversee the coordination of group-wide information sharing. The head office should be informed of information regarding high-risk customers. Local data protection and privacy laws must be considered.

For larger banks, the ability to centralize bank processing systems and databases may allow for more effective and efficient risk management.

Role of Supervisors

Bank supervisors are expected to:

- Comply with FATF Recommendation 26 and apply the *Core Principles for Effective Banking Supervision* as it relates to the supervision of AML/CFT risks. FATF states the principles that are relevant to money laundering and the financing of terrorism.
- Set out supervisory expectations governing banks' AML/CFT policies and procedures.
- Adopt a risk-based approach to supervising banks' ML/FT risk management systems. To that end, supervisors must:
  - Understand the risks present in other jurisdictions and the impact on the supervised banks.
  - Evaluate the adequacy of the bank's risk assessment based on the jurisdiction's national risk assessments.
  - Assess the bank's risks in terms of the customer base, products and services, and geographical locations in which the bank and its customers do business.
  - Evaluate the effectiveness in implementation of the controls (e.g., CDD) designed by the bank to meet AML/CFT obligations.
  - Allocate resources to conduct effective reviews of the identified risks.
  - Protect the integrity of the financial system by protecting the safety and soundness of banks relative to ML/FT risk management. This means making it clear that supervisors will take action, action that may be severe and public, against banks and their officers who fail to follow their own internal procedures and regulatory requirements.
  - Make sure the stricter of two jurisdictions' requirements is applied.
  - Verify a bank's compliance with group-wide AML/CFT policies and procedures during on-site inspections.
  - Extend full cooperation and assistance to home-country supervisors who need to assess a bank's overseas compliance with group-wide AML/CFT policies and procedures.
  - Ensure there is a group audit and determine the scope and frequency of audits of the group's AML/CFT risk management procedures.
  - Ensure the confidentiality of customer information provided to supervisors.
  - Make sure that supervisors are not classified as "third parties" in countries where there are restrictions on the disclosure of customer information to third parties.

LO 61.4: Explain policies and procedures a bank should use to manage ML/FT risks in situations where it uses a third party to perform customer due diligence and when engaging in correspondent banking.

In some countries banks may rely on third parties to perform CDD. These third parties may be other financial institutions or designated non-financial businesses and professionals who are supervised or monitored for AML/CFT purposes. The FATF standards allow banks to rely on third parties for:

1. Identifying the customer and verifying the customer's identity using reliable, independent information.

2. Identifying and verifying the identity of the beneficial owner.

3. Understanding and obtaining information on the purpose of the intended nature of the business relationship.

The bank, relying on a third party to perform these functions, should immediately obtain the information concerning the CDD.

Banks may outsource CDD obligations, and generally fewer restrictions apply in terms of who can act as the agent of the bank. The lower level of restrictions is offset by record-keeping requirements.

Reliance on a Third Party

Reliance on a third party does not relieve the bank of its responsibilities in terms of CDD and other AML/CFT requirements on customers. Relevant criteria for assessing reliance on a third party include:

- The third party should be as comprehensively regulated and supervised as the bank. Alternatively, national laws may require the use of compensating controls where these standards are not met.
- There should be a written agreement between the parties acknowledging the bank's reliance on the third party for its CDD.
- The bank's policies and procedures must acknowledge this arrangement and establish adequate controls and review processes for the third party arrangement.
- The third party should implement the bank's AML program, and may be required to certify that it has done so and that it performs CDD equivalent to the bank's obligations and requirements.
- The bank should be aware of adverse publicity regarding the third party, such as enforcement actions for AML deficiencies or violations.
- The bank should identify and mitigate risks posed by relying on a third party for CDD rather than maintaining a direct relationship with the customer.
- The bank's risk assessment should acknowledge the potential risk factors produced by relying on a third party for CDD.
- The bank should periodically review the third party's CDD and should obtain documentation from the third party that it relies upon and assesses the due diligence processes and procedures, ensuring that the third party is complying with local regulatory requirements by screening against local databases.

- The bank should terminate the relationship with a third party that does not apply adequate CDD on their customers or fails in some way to meet the bank's requirements or expectations.

If a bank relies on another financial institution in the group to introduce it to customers in other countries, the institution must ensure that the customer identification by the introducer complies with the previously listed criteria.

Outsourcing/Agency

Banks may engage in CDD directly or outsource the activity, sometimes in an agent relationship. If outsourced, it does not relieve the bank of its compliance responsibilities, which still lie with the bank. Banks that work more over the phone or internet and/or have few "brick and mortar" branches tend to use third parties to a greater extent. Banks often use retail deposit brokers, mortgage brokers, and solicitors to apply and meet their customer identification obligations. A written agreement between the parties should set forth the AML/CFT obligations of the bank and explain how they will be executed by the third party. The written agreement should include the following requirements that the:

- Bank's customer identification and CDD requirements be applied by the agent.
- Agent use original identification documents to identify the customer when the customer is present in person.
- Third party adheres to the bank's policies when the customer is not present at the time of customer identification.
- Customer's information remains confidential.

In addition, the bank should:

- Ensure that the agent or third party determines the identity of beneficial owners or PEPs.
- Ensure that the agent or third party provides the bank with customer identification information in the required time frame.
- Review and audit the quality of the customer information that is gathered and documented.
- Clearly identify instances the bank would consider failures to perform the contracted duties.
- Ensure that data provided by the third party is complete, accurate, and timely.

An agent, under the law of agent and principal, is generally considered a legal extension of the bank. This means the customer is legally dealing with the bank itself and the agent is, therefore, obligated to apply the bank's policies and procedures regarding customer identification, verification, and CDD.

The third party must have technical expertise, knowledge, and training regarding customer identification and CDD. In some cases, the third party is not subject to AML/CFT obligations itself. Even if the agent does not have AML/CFT obligations, it must apply the principal's identification and CDD requirements, and conform to the principal's legal requirements.

Correspondent Banking – A Risk Based Approach

Correspondent banking relationships allow the respondent bank to provide services that it could not otherwise provide. According to the FATF, a correspondent banking relationship is ongoing and repetitive in nature. Cross-border correspondent banking involving the execution of third party payments is higher risk and, according to FATF Recommendation 13, should prompt additional CDD measures. Cross-border correspondent relationships allow respondent banks without international presence or cross-border payment systems to operate in jurisdictions to which they would otherwise not have access.

The correspondent bank does not generally have a direct relationship with the respondent bank's customers. They are in fact the customers of the respondent bank and, thus, the correspondent bank must conduct due diligence on the respondent bank, but not on the respondent bank's customers. The respondent bank must conduct CDD. However, this also means the correspondent bank may be exposed to greater ML/FT risks because of limited information regarding the nature and purpose of the underlying transactions of the respondent bank's customers.

Risk indicators arising from cross-border correspondent banking include:

- The inherent risks resulting from the nature of the services provided by the correspondent bank including:
  - The purpose of the services provided (e.g., foreign exchange services for proprietary trading, securities trading on exchanges, and so on may indicate lower risk).
  - Whether the services will be used via **nested (downstream) correspondent banking** by bank affiliates or third parties, and the risks that doing business with these parties entail. *Nested* (or *downstream*) refers to the use of correspondent banking services by a number of respondent banks through the relationship with the correspondent bank's direct respondent bank to conduct financial transactions and gain access to services.
  - Whether services will be used via payable-through account(s) activity by the respondent bank's affiliates or third parties and the risks these parties introduce.
- The characteristics of the respondent bank, including the respondent bank's:
  - Major business activities (e.g., target markets, types of customers served, key business lines).
  - Management and ownership.
  - Money laundering prevention and protection policies and procedures such as the CDD processes.
  - History, including whether any sanctions, criminal, civil, or administrative actions have occurred and how it was addressed by the respondent bank.
- The environment in which the respondent bank operates, including:
  - The jurisdiction of the respondent bank and its parent.
  - The jurisdiction of the subsidiaries and branches of the group.
  - The quality and effectiveness of bank regulation and supervision in the respondent bank's country.

Nested (Downstream) Correspondent Banking

Nested or downstream correspondent banking is necessary and generally legitimate. Regional banks can assist small, local banks in the respondent's region to gain access to the international financial system. However, these foreign institutions are not customers of the correspondent bank and, as they are not known, may increase ML/FT risks. The respondent bank should, therefore, disclose whether accounts include nested relationships. The correspondent bank should assess the risks on a case-by-case basis. Correspondent banks should consider:

- The number and types of financial institutions the respondent bank serves.
- The jurisdiction of the nested institutions and whether those jurisdictions have adequate AML/CFT policies according to available public information.
- The types of services the respondent bank offers the nested institutions.
- The length of the relationship between the correspondent and respondent banks.
- The adequacy of the due diligence processes and procedures of the respondent bank.

The correspondent bank should gather information about the respondent bank before entering a business relationship. Information about the respondent bank's AML/CFT policies is essential and can be gathered from the respondent bank. The correspondent bank may use third-party databases (referred to as *know your customer* or *KYC utilities*) at account opening and must update this information over time. Correspondent banks may also use public sources to gather information. The correspondent bank should also consider relevant information on the jurisdiction in which the respondent resides before entering into a banking relationship.

The level of due diligence should be commensurate with the respondent bank's risk profile. The correspondent bank should assess the risk and the respondent bank's AML/CFT controls by gathering information, checking the functioning of the internal audit, and so on. Correspondent banks should not engage in a relationship with a "shell" bank (i.e., one that has no physical presence in a jurisdiction and no affiliation with a regulated financial group).

Banks should engage in ongoing monitoring activities of respondent banks. If a transaction is suspicious, the correspondent bank can issue a "request for information" on the transaction.

In cross-border wire transfers, the Committee encourages all banks to apply high transparency. **Payment messages** must be in the correct form and must identify the originator and the beneficiary of the payment, and then must be monitored by those in the payment chain. The respondent bank, acting as the ordering financial institution, remains responsible for performing CDD. It is essential that the information in payment messages unambiguously identifies the originator and the beneficiary of the payment.

Professor's Note: Payment messages are the written instructions that go along with payments. There are messages when a payment is due, issued, canceled, and so on. Payment messages also contain information on the originator of the payment and the beneficiary. The Committee requires that everyone in the payment chain monitor the payments they process based on the information in the payment messages. This should in turn increase transparency and lower the ML/FT risk.

If a respondent bank has a relationship with several entities in the same group, then risk assessments by different entities must be consistent with the group-wide risk assessment policy. The group's head office should coordinate the monitoring of the relationship with the respondent bank. This is especially important in the case of high-risk relationships. If the relationship is with the same group but in different host countries, the correspondent bank must assess the ML/FT risks presented in each business relationship.

Key Concepts

LO 61.1

To assess money laundering and the financing of terrorism (ML/FT) risks, the bank must know the identities of its customers and must have policies and procedures for:

- Customer identification.
- Customer due diligence (CDD).
- Customer acceptance.
- Monitoring of business relationships.
- Monitoring of business operations.

To mitigate ML/FT risks, the first line of defense is the business units (e.g., the front office and customer facing activities). They identify, assess and control ML/FT risks through policies and procedures that should be specified in writing and communicated to bank personnel. The second line of defense is the chief officer in charge of anti-money laundering and countering financing of terrorism (AML/CFT). The officer should engage in ongoing monitoring and the fulfillment of AML/CFT duties. The third line of defense is internal audits. The bank should establish policies for conducting internal audits of the bank's AML/CFT policies.

LO 61.2

Banks must determine which customers pose a high risk of ML/FT. Factors the bank should consider include the customer's background, occupation, sources of income and wealth, the country of origin and the country of residence, the choice and use of the bank's products and services, the nature and purpose of the bank account, and any linked accounts. Banks must, according to the Financial Action Task Force (FATF) standards, identify customers and verify their identities. Banks must establish a systematic procedure for identifying and verifying customers. In some cases, the bank must identify and verify a person acting on behalf of a beneficial owner(s). Customer identification documentation may include passports, identity cards, driving licenses, and account files such as financial transaction records and business correspondence.

LO 61.3

Banks involved in cross-border activities should:

- Integrate information on the customer, beneficial owners of the customer (if one exists), and the funds involved in the transaction(s).
- Monitor significant customer relationships, balances, and activity on a consolidated basis whether the account is on- or off-balance sheet, as assets under management (AUM) or on a fiduciary basis.
- Appoint a chief AML/CFT officer for the whole group (the group of banks and branches that are part of one financial organization) who must ensure group-wide compliance (across borders) of AML/CFT requirements.
- Oversee the coordination of group-wide information sharing. The head office should be informed of information regarding high-risk customers. Local data protection and privacy laws must be considered.

Bank supervisors must comply with FATF Recommendation 26 and apply the *Core Principles for Effective Banking Supervision* as it relates to the supervision of AML/CFT risks. FATF states the principles that are relevant to money laundering and financing of terrorism. They must also set out supervisory expectations governing banks' AML/CFT policies and procedures and should adopt a risk-based approach to supervising banks' ML/FT risk management systems.

LO 61.4

In some cases, banks rely on third parties to perform CDD. The FATF standards allow banks to rely on third parties to (1) identify the customer and verify the customer's identity using reliable, independent information, (2) identify and verify the identity of the beneficial owner, and (3) understand and obtain information on the purpose and the intended nature of the business relationship with the customer. However, reliance on a third party does not relieve the bank of its responsibilities in terms of CDD and other AML/CFT requirements on customers.

Banks may engage in CDD directly or outsource the activity, sometimes in an agent relationship. If outsourced, it does not relieve the bank of its compliance responsibilities, which still lie with the bank.

Correspondent banking relationships allow the respondent bank to provide services that it could not provide otherwise. Risk indicators arising from cross-border correspondent banking include the inherent risks resulting from the nature of the services provided by the correspondent bank including the characteristics of the respondent bank, which involve the respondent bank's major business activities and the environment in which the respondent bank operates.

Nested (or downstream) refers to the use of correspondent banking services by a number of respondent banks through the relationship with the correspondent bank's direct respondent bank to conduct financial transactions and gain access to services. The foreign institutions (respondent banks) are not customers of the correspondent bank and, as they are not known, may increase ML/FT risks. The respondent bank should, therefore, disclose whether accounts include nested relationships and monitor accordingly. In cross-border wire transfers, the Committee encourages all banks to apply high transparency. Payment messages must be in the correct form and must identify the originator and the beneficiary of the payment, and then must be monitored by those in the payment chain.

Concept Checkers

1. Which of the following is an example of external data that the chief Anti-Money Laundering and Countering Financing of Terrorism (AML/CFT) officer should analyze and understand in order to manage and mitigate money laundering and the financing of terrorism (ML/FT) risks?
   A. Transaction data.
   B. Payment message streams.
   C. Country reports.
   D. Customer passports and identity card.

2. With respect to managing and mitigating money laundering and the financing of terrorism (ML/FT) risks in a bank, bank tellers and branch managers are examples of:
   A. the first line of defense.
   B. the second line of defense.
   C. the most important line of defense.
   D. lower level bank employees that have little to do with financial crimes risk management.

3. The risk manager of a large U.S. multi-national bank is attempting to put in greater risk controls. In keeping with recommendations from the Basel Committee on the sound management of risks related to money laundering and the financing of terrorism (ML/FT) she requires enhanced customer due diligence (CDD) for:
   A. all accounts from customers initiated in countries outside the United States.
   B. accounts with regular cross-border wire transfers.
   C. individual accounts with balances less than the $250,000 Federal Deposit Insurance Corporation (FDIC) insurance limit.
   D. accounts of persons who reside in countries other than their countries of birth.

4. Which of the following is the role of a bank supervisor, acting in its role regarding the supervision of Anti-Money Laundering and Countering Financing of Terrorism (AML/CFT) risks?
   A. Require all banks to use the same global payment systems to make detection of irregularities simpler.
   B. Make sure all banks have a chief AML/CFT risk manager that reports directly to the board of directors.
   C. Require all banks to provide daily documentation to the supervisor on any cross-border wire transfers.
   D. Make sure the stricter of the two jurisdictions' rules regarding ML/FT risks are applied by banks.

5. When a correspondent bank provides products or services to a respondent bank that then offers these services to other banks, it is known as:
   A. nested correspondent banking—it is legal but can increase the risks of money laundering and the financing of terrorism.
   B. upstream correspondent banking—it is illegal and will increase the risks of money laundering and the financing of terrorism.
   C. diversified correspondent banking—it is legal and does not increase the risks of money laundering and the financing of terrorism.
   D. downstream correspondent banking—it is illegal and will increase the risks of money laundering and the financing of terrorism.

Concept Checker Answers

1. **C** The bank's understanding of inherent money laundering and the financing of terrorism (ML/FT) risks is based on both internal and external data sources including operational and transaction data (internal) and national risk assessments and country reports from international organizations (external).

2. **A** To mitigate ML/FT risks, the first line of defense is the business units (e.g., the front office and customer facing activities). They identify, assess, and control ML/FT risks through policies and procedures that should be specified in writing and communicated to bank personnel. The second line of defense is the chief officer in charge of AML/CFT. The third line of defense is internal audits.

3. **B** Banks must determine which customers pose a high risk of ML/FT. Factors the bank should consider include the customer's background, occupation, business activities, sources of income and wealth, country of origin, country of residence, if different from country of origin, choice and use of bank products and services, nature and purpose of the bank account, and any linked accounts. For lower-risk customers, simplified assessment procedures may be used (e.g., a customer with low balances who uses the account for routine banking needs). Enhanced due diligence may be required for:
   - Accounts with large balances and regular cross-border wire transfers.
   - A politically exposed person (PEP), especially foreign PEPs.

4. **D** Bank supervisors have many jobs in conjunction with ML/FT risks, including complying with FATF Recommendation 26 and applying the *Core Principles for Effective Banking Supervision* as it relates to the supervision of AML/CFT risks. Supervisors should make sure the stricter of two jurisdictions' requirements is applied. They do not, however, require banks to use the same payment systems, require daily documentation of cross-border wire transfers be submitted to the supervisor, or require banks to have a chief AML/CFT officer that reports to the board (although it is recommended that banks have an officer that reports to the board and/or senior management).

5. **A** Nested (or downstream) refers to the use of correspondent banking services by a number of respondent banks through the relationship with the correspondent bank's direct respondent bank to conduct financial transactions and gain access to services. Nested or downstream correspondent banking is necessary, legal, and generally legitimate. However, the foreign institutions are not customers of the correspondent bank and, as they are not known, may increase money laundering and the financing of terrorism (ML/FT) risks.

Self-Test: Operational and Integrated Risk Management

10 Questions: 30 Minutes

1. Outsourcing may reduce costs, provide expertise, expand bank offerings, and/or improve bank services. The board of directors and senior management must understand the operational risks that are introduced as a result of outsourcing. Which of the following actions is(are) suggested by the Basel Committee for controlling risks related to outsourcing?

   I. An agreement detailing termination rights and other rights and responsibilities of the two parties involved.
   II. Established policies for restitution in the event of failure on the part of an outside service provider.

   A. I only.
   B. II only.
   C. Both I and II.
   D. Neither I nor II.

2. There are five major factors that could lead to a poor or fragmented IT infrastructure at an organization. Which of the following factors is least likely to result in a poor or fragmented IT infrastructure?
   A. Moderate turnover of key IT staff.
   B. Participating in merger and acquisition activities.
   C. Management of a firm that is focused primarily on long-term projects.
   D. Allowing each business line the autonomy to upgrade their IT systems based on the best available resources.

3. The generalized Pareto distribution is used for modeling extreme losses. The model requires the choice of a threshold. Which of the following best describes the tradeoffs in setting the threshold level?
   A. The threshold must be high enough so that the tail index indicates a heavy tail.
   B. The threshold must be high enough so that the tail index indicates a light tail.
   C. The threshold must be high enough so that convergence to the generalized Pareto distribution occurs.
   D. The threshold must be high enough so that there are enough observations to estimate the parameters.

4. Given the following data for a project, which of the following statements is most accurate regarding the use of the risk-adjusted return on capital (RAROC)?

- Equity beta: 1.2
- Market return: 13%
- Variance of returns: 5%
- RAROC: 16%
- Risk-free rate: 4%

I. Using the adjusted RAROC, the project should be rejected because the RAROC is less than the market return plus the risk-free rate.
II. Using the adjusted RAROC, the project should be accepted because its adjusted RAROC is higher than the risk-free rate.

A. I only.
B. II only.
C. Both I and II.
D. Neither I nor II.

5. You are holding 100 SkyTrek Company shares with a current price of \$30. The daily mean and volatility of the stock return are 2% and 3%, respectively. VaR should be measured relative to initial wealth. The bid-ask spread of the stock varies over time, and the daily mean and volatility of this spread are 0.5% and 1%, respectively. Both the return and spread are normally distributed. What is the daily liquidity-adjusted VaR (LVaR) at a 99% confidence level assuming the confidence parameter of the spread is equal to 3?
A. \$103.50.
B. \$172.62.
C. \$193.15.
D. \$202.20.

6. A recently published article on issues with value at risk (VaR) estimates included the following statements.

Statement 1: Differences in the use of confidence intervals and time horizon can cause significant variability in VaR estimates as there is lack of uniformity in practice.
Statement 2: Standardization of confidence interval and time horizon would eliminate most of the variability in VaR estimates.

This article's statements are most likely correct with regard to:
A. Statement 1 only.
B. Statement 2 only.
C. Both statements.
D. Neither statement.

7. Global Transportation, Inc., recently traded at an ask price of \$45 and a bid price of \$44.50. The sample standard deviation of the bid-ask spread was 0.0001. The 99% spread risk factor for a purchase of Global Transportation is closest to:
A. 0.0057.
B. 0.2541.
C. 25.41.
D. 0.1111.

8. The standardized model for market risk charges differs from the internal model-based approach in that the standardized model:
   A. sums up market risks across market risk categories, whereas the internal model-based approach uses a multiplicative factor on the average VaR.
   B. sums up market risks across market risk categories, whereas the internal model-based approach focuses solely on specific risk charges.
   C. focuses solely on specific risk charges, whereas the internal model-based approach sums up market risks across market-risk categories.
   D. uses a multiplicative factor on the average VaR, whereas the internal model-based approach sums up market risks across market risk categories.

9. Given the following information, what is Bank X's net stable funding ratio (NSFR)?
   - High-quality liquid assets: $100
   - Required amount of stable funding: $200
   - Cash outflows over the next 30 days: $130
   - Net cash outflows over the next 30 days: $90
   - Available amount of stable funding: $210

   A. 65%.
   B. 89%.
   C. 105%.
   D. 125%.

10. Global Bank has been unwilling to appoint a chief Anti-Money Laundering and Countering Financing of Terrorism (AML/CFT) officer. As a result, the bank has had several incidents involving money laundering, some of which have been reported on in the press. Which of the following is not a key risk associated with weak money laundering and the financing of terrorism (ML/FT) risk management practices?
    A. Market risk.
    B. Operational risk.
    C. Compliance risk.
    D. Concentration risk.

Self-Test Answers: Operational and Integrated Risk Management

1. **A** Outsourcing policies should include:
   - Processes and procedures for determining which activities can be outsourced and how the activities will be outsourced.
   - Processes for selecting service providers (e.g., due diligence).
   - Structuring the outsourcing agreement to describe termination rights, ownership of data, and confidentiality requirements.
   - Monitor risks of the arrangement including the financial health of the service provider.
   - Implement a risk control environment and assess the control environment at the service provider.
   - Develop contingency plans.
   - Clearly define responsibilities of the bank and the service provider.

   The Basel Committee does not explicitly suggest establishing policies for restitution in the event of failure on the part of the outside service provider although this could be detailed in the outsourcing agreement.

   (See Topic 37)

2. **C** Management of a firm that is focused less on short-term financial issues and more on long-term survival is much less likely to encounter problems with poor or fragmented IT infrastructures. Moderate turnover in IT staff, especially key staff, will likely contribute to the problem. Merger and acquisition activity will often result in multiple systems running at the same time so that data aggregation across products and business lines becomes a significant new challenge. Allowing autonomy to each business line will likely result in inconsistency across business lines and could be costly if the systems end up being incompatible due to the inconsistency.

   (See Topic 39)

3. **C** The threshold must be high enough so that convergence to the generalized Pareto distribution occurs. Choices A and B are incorrect because the tail index is chosen by the researcher. Heavy tails are indicated by a tail index greater than zero. Choice D is incorrect because the threshold must be low enough so that there are enough observations to estimate the parameters.

   (See Topic 45)

4. **B** The adjusted RAROC (ARAROC) compares the adjusted RAROC to the risk-free rate. So Statement I is incorrect.

   The project should be accepted because the ARAROC of 5.2% is greater than the risk-free rate of 4%. So Statement II is correct.

   ARAROC = 0.16 – 1.2(0.13 – 0.04) = 0.052.

   (See Topic 48)

5. **D** At the 99% confidence level, you would use an alpha statistic of 2.33 since VaR is a one-tailed test. The liquidity-adjusted VaR = normal VaR + adjustment for liquidity.

   Normal VaR = portfolio value × (mean – 2.33 × standard deviation)

   Normal VaR = 100 × \$30 × (2% – 2.33 × 3%)

   Normal VaR = \$149.70 (Note that a negative sign is implied here since we are dealing with the value at risk.)

   Liquidity adjustment = 0.5 × portfolio value (spread mean + 3 × spread volatility)

   Liquidity adjustment = 0.5 × \$3,000 × (0.5% + 3 × 1%) = \$52.5

   LVaR = \$149.70 + \$52.5 = \$202.20

   (See Topic 52)

6. **A** Statement 1 is correct as variability in risk measures, including lack of uniformity in the use of confidence intervals and time horizons, can lead to variability in VaR estimates. Statement 2 is incorrect as other factors can also cause variability, including length of the time series under analysis, ways of estimating moments, mapping techniques, decay factors, and number of simulations.

   (See Topic 53)

7. **A** The formula for the expected transactions cost confidence interval is:

   $+/- P \times \frac{1}{2}(s + 2.33\sigma_s)$

   where:
   P = an estimate of the next day asset midprice, usually set to *P*, the most recent price observation.
   s = expected or typical bid-ask spread calculated as (ask price – bid price) / midprice
   σ_s = sample standard deviation of the spread

   The $\frac{1}{2}(s + 2.33\sigma_s)$ component of the confidence interval is referred to as the 99% spread risk factor.

   Midprice = (45 + 44.50) / 2 = 44.75

   s = (45 – 44.5) / 44.75 = 0.0112

   spread risk factor = ½[0.0112 + 2.33(0.0001)] = 0.0057

   (See Topic 54)

8. **A** The standardized model approach simply sums the market risks across the market-risk categories. The internal model-based approach applies a multiplicative factor to the average VaR.

   (See Topic 58)

9. **C** The longer-term funding ratio is equal to the available amount of stable funding divided by the required amount of stable funding. Under Basel III, this ratio must equal or exceed 100%. Bank A's net stable funding ratio = $210 / $200 = 105%.

   (See Topic 59)

10. **A** Banks without sound ML/FT risk management practices are exposed to serious risks including reputational, operational, compliance, and concentration risks.

    (See Topic 61)

Formulas

Topic 43

basic indicator approach:

$$K_{BIA} = \frac{\left(\sum_{i=1}^{n} GI_i \times \alpha\right)}{n}$$

where:
GI = annual (positive) gross income over the previous three years
n = number of years in which gross income was positive
α = 15% (set by Basel Committee)

the standardized approach:

$$K_{TSA} = \frac{\left\{\sum_{3\ Years} \max\left[\sum(GI_{1-8} \times \beta_{1-8}), 0\right]\right\}}{3}$$

where:
$GI_{1\text{-}8}$ = annual gross income in a given year for each of the eight business lines
$\beta_{1\text{-}8}$ = beta factors (fixed percentages for each business line)

Topic 44

business indicator:

$$BI = ILDC_{avg} + SC_{avg} + FC_{avg}$$

where:
ILDC = interest, lease, dividend component
SC = services component
FC = financial component

internal loss multiplier:

$$\text{internal loss multiplier} = \ln\left(e^1 - 1 + \frac{\text{loss component}}{\text{BI component}}\right)$$

where:
loss component =
7 × average total annual loss
+ 7 × average total annual loss only including loss events above €10 million
+ 5 × average total annual loss only including loss events above €100 million

Topic 45

generalized extreme value (GEV) distribution:

$$F(X \mid \xi, \mu, \sigma) = \exp\left[-\left(1 + \xi \times \frac{x - \mu}{\sigma}\right)^{-1/\xi}\right] \text{ if } \xi \neq 0$$

$$F(X \mid \xi, \mu, \sigma) = \exp\left[-\exp\left(\frac{x - \mu}{\sigma}\right)\right] \text{ if } \xi = 0$$

generalized Pareto distribution:

$$1 - \left[1 + \frac{\xi x}{\beta}\right]^{-1/\xi} \text{ if } \xi \neq 0$$

$$1 - \exp\left[-\frac{x}{\beta}\right] \text{ if } \xi = 0$$

Topic 48

economic capital:

economic capital = risk capital + strategic risk capital

RAROC:

$$\text{RAROC} = \frac{\text{after-tax expected risk-adjusted net income}}{\text{economic capital}}$$

$$\text{RAROC} = \frac{\begin{pmatrix}\text{expected revenues} - \text{costs} - \text{expected losses} \\ - \text{taxes} + \text{return on economic capital} \pm \text{transfers}\end{pmatrix}}{\text{economic capital}}$$

hurdle rate:

$$h_{AT} = \frac{[(CE \times R_{CE}) + (PE \times R_{PE})]}{(CE + PE)}$$

where:
CE = market value of common equity
PE = market value of preferred equity
R_{CE} = cost of common equity [could be derived from the capital asset pricing model (CAPM)]
R_{PE} = cost of preferred equity (yield on preferred shares)

adjusted RAROC:

$$\text{Adjusted RAROC} = \text{RAROC} - \beta_E (R_M - R_F)$$

Topic 52

$$\text{spread} = \frac{(\text{ask price} - \text{bid price})}{(\text{ask price} + \text{bid price})/2}$$

liquidity-adjusted VaR (constant spread):

$$\text{LVaR} = (V \times z_\alpha \times \sigma) + [0.5 \times V \times \text{spread}]$$

$$\text{LVaR} = \text{VaR} + \text{LC}$$

where:
V = asset (or portfolio) value
z_α = confidence parameter
σ = standard deviation of returns

lognormal VaR: $\text{VaR} = [1 - \exp(\mu - \sigma \times z_\alpha)] \times V$

$$\frac{\text{LVaR}}{\text{VaR}} = 1 + \frac{\text{spread}}{2 \times [1 - \exp(-\sigma \times z_\alpha)]}$$

elasticity: $E = \dfrac{\Delta P/P}{\Delta N/N}$

where:
$\Delta N/N$ = size of the trade relative to the entire market

$$\text{LVaR} = \text{VaR} \times \left(1 - \frac{\Delta P}{P}\right) = \text{VaR} \times \left(1 - E \times \frac{\Delta N}{N}\right)$$

$$\left.\frac{\text{LVaR}}{\text{VaR}}\right|_{\text{combined}} = \left.\frac{\text{LVaR}}{\text{VaR}}\right|_{\text{exogenous}} \times \left.\frac{\text{LVaR}}{\text{VaR}}\right|_{\text{endogenous}}$$

Topic 54

leverage ratio: $L = \dfrac{A}{E} = \dfrac{(E + D)}{E} = 1 + \dfrac{D}{E}$

leverage effect: ROE = (leverage ratio × ROA) – [(leverage ratio – 1) × cost of debt]

transactions cost confidence interval: +/– $P \times \frac{1}{2}(s + 2.33\sigma_s)$

where:
P = an estimate of the next day asset midprice, usually set to *P*, the most recent price observation
s = expected or typical bid-ask spread
σ_s = sample standard deviation of the spread

spread risk factor: $\frac{1}{2}(s + 2.33\sigma_s)$

Topic 58

credit equivalent amount:

max(V, 0) + a × L

where:
V = current value of the derivative to the bank
a = add-on factor
L = principal amount

market risk capital requirement:

$$\max(\text{VaR}_{t-1}, m_c \times \text{VaR}_{avg}) + \text{SRC}$$

where:
VaR_{t-1} = previous day's VaR
VaR_{avg} = the average VaR over the past 60 trading days
m_c = multiplicative factor
SRC = specific risk charge

expected loss:

$$\text{EL} = \sum_i \text{EAD}_i \times \text{LGD}_i \times \text{PD}_i$$

required capital = EAD × LGD × (WCDR – PD) × MA

where:
MA = maturity adjustment = $(1 + (M - 2.5) \times b)/(1 - 1.5 \times b)$
M = maturity of the exposure
b = $[0.11852 - 0.05478 \times \ln(\text{PD})]^2$

total capital = 0.08 × (credit risk RWA + market risk RWA + operational risk RWA)

Topic 59

stressed VaR:

$$\max(\text{VaR}_{t-1}, m_c \times \text{VaR}_{avg}) + \max(\text{SVaR}_{t-1}, m_s \times \text{SVaR}_{avg})$$

where:
VaR_{t-1} = previous day's VaR, 10-day time horizon, 99% confidence level
VaR_{avg} = the average VaR over the past 60 days, 10-day time horizon, 99% confidence level
m_c = multiplicative factor, determined by supervisor, minimum value of three
SVaR_{t-1} = previous day's stressed VaR, 10-day time horizon, 99% confidence level
SVaR_{avg} = the average stressed VaR over the past 60 days, 10-day time horizon, 99% confidence level
m_s = stressed VaR multiplicative factor, determined by supervisor, minimum of three

liquidity coverage ratio:

high quality liquid assets / net cash outflows in a 30-day period $\geq$ 100%

net stable funding ratio:

amount of available stable funding / amount of required stable funding $\geq$ 100%

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